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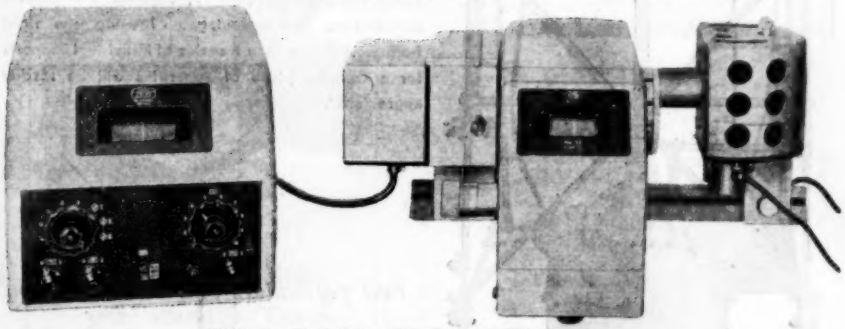

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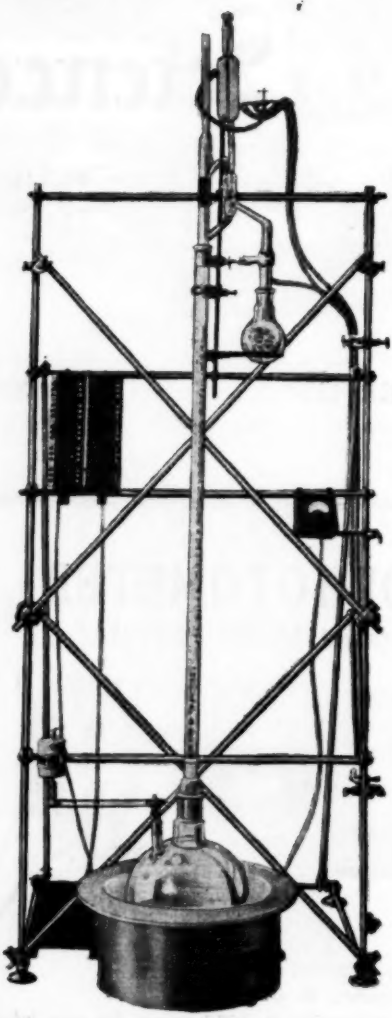

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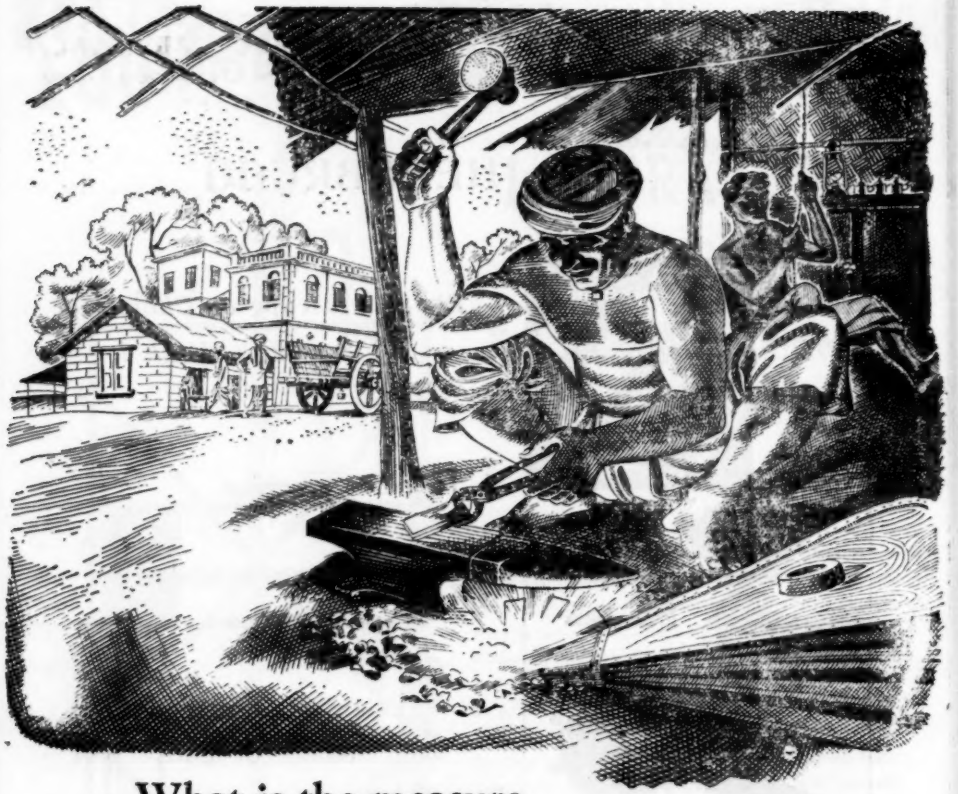

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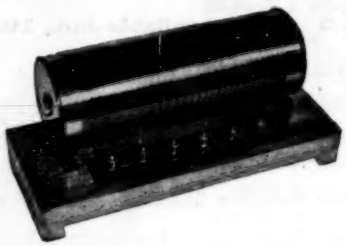

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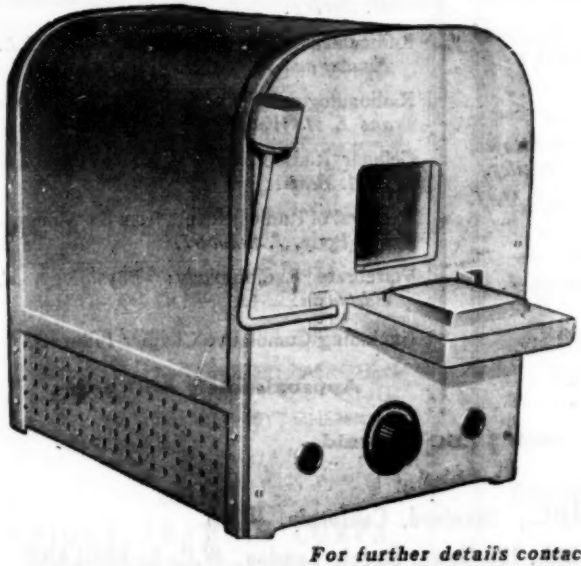

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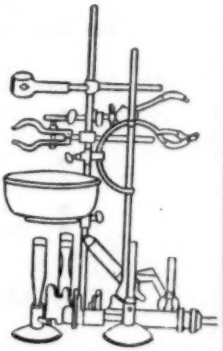

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X-RAYS AND CRYSTALS*

By

Sir C. V. Raman

IT is familiar knowledge that every crystal is a three-dimensionally periodic grouping in space of atomic nuclei and electrons held together by their mutual interactions so as to form a rigid solid. We recognise in each crystal a unit of its structure containing, say, a group of p atoms, this group repeating itself at regular intervals along three directions which are designated as the axes of the structure. The atoms in the crystal may accordingly be regarded as consisting of p sets, all the atoms of a particular set being equivalent to each other and located at regular intervals in a space lattice whose axes are those of the crystal.

2. Diffraction of X-Rays by Crystals

That the geometric picture of crystal architecture briefly indicated above is not just a mathematical hypothesis but a physical reality was first demonstrated by the famous experiment of Laue and his collaborators. When a narrow pencil of X-rays traverses a crystal and is received on a photographic film held behind it, a pattern of spots surrounding the impress of the incident beam appears on the film when developed. It is well recognised that these Laue spots—as they are called—represent monochromatised reflections of the incident X-ray beam by the stratifications of the electron density parallel to the various crystallographic planes in the structure of the crystal. The intensity of each spot is indicative of the magnitude of the corresponding periodic variations of electron density normal to the planes under consideration. The theory of the Laue experiment can be dealt with in a purely classical manner by attributing a certain scattering power to each volume

* Presidential Address to the Indian Academy of Sciences at the Hyderabad Meeting on 27th December, 1955.

element in the electron cloud present in the crystal proportional to its local density. This scattering power derives from the fact that the electrons would be set in motion and oscillate with the same frequency as that of the electro-magnetic field which the incident X-ray beam represents. On this basis, the scattered radiations from all the volume elements would have the same frequency as the incident X-rays, as also specific phase relationships determined by their relative positions. The scattered radiations therefore would be capable of reinforcing each other's effects in certain specific directions determined by the wave-length of the X-rays and the spacing of the stratifications, in accordance with recognised optical principles. Concentrations of intensity accordingly appear in the directions representing a highly restricted selection of wave-lengths from the incident white X-radiation.

3. Atomic Nuclei and X-Ray Diffraction

The foregoing picture is obviously however an over-simplification. It implicitly assumes that the electrons which scatter the X-rays remain firmly bound to the structure of the crystal and that the latter also remains otherwise unaffected by the passage of the X-ray beam. The strength of the binding of the electrons to the atomic nucleus or nuclei closest to them necessarily enters into the picture and would influence the intensity and phase of the scattered radiations to an extent determined by the approach of the frequency of the incident X-radiation to the characteristic X-ray absorption frequencies of the electrons. Indeed, recent X-ray researches have shown that these factors have to be taken into account in the theory of X-ray diffraction by crystals.

The foregoing remarks indicate that considerations somewhat analogous to those which enter into the theory of scattering of light in crystals need to be taken into account also in the theory of X-ray diffraction. When a beam of common light traverses a crystal, its wave-length is very great in comparison with the spacing of the electronic stratifications in the crystal and the latter do not therefore reflect the incident radiation but merely transmit it. On the other hand, it is known that the passage of the light excites vibrations of the atomic nuclei with the result that if the incident light be monochromatic, scattered radiations are observed exhibiting sharply defined shifts of frequency corresponding to the characteristic vibration frequencies of the atomic nuclei about their positions of equilibrium. The appearance of such scattered radiations indicates the existence of a coupling between the forced vibrations of the electrons under the influence of the incident electromagnetic field and the natural or free vibrations of the atomic nuclei about their positions of equilibrium. In the language of the quantum theory of dispersion, the appearance of such frequency shifts is described by the statement that the system composed of the nuclei and electrons does not—following the virtual transitions to higher energy states induced by the incident radiation—return to the same level as previously but shifts to a third level in which the atomic nuclei are in a different energy state of vibration.

In the X-ray experiment, the frequency of the incident radiation is usually much higher than the characteristic frequencies of the electrons. Nevertheless, the ideas of the quantum theory of dispersion continue to be applicable and the question therefore arises whether the incident X-radiations can also excite transitions in the energy state of the atomic nuclei by virtue of their mechanical coupling with the electrons and if so, what would be the observable result of such transitions. We shall now proceed to answer these questions.

4. The Characteristic Vibrations of Crystal Lattices

As remarked earlier, the fundamental feature of crystal architecture is that it is

a repetitive pattern in three-dimensional space of a characteristic unit of the structure containing a finite number of atoms. Each unit of the structure is similar to and similarly situated with respect to the units surrounding it. Hence it follows that in respect of all their physical properties the units of the crystal structure would be similar to each other ; in particular the dynamic behaviour of all the units of the crystal structure would be completely identical. We may put the same situation in slightly different language by saying that every crystal is an assembly of atomic oscillators all of which have identical modes and frequencies of vibration. What these modes and frequencies are is a matter for rigorous mathematical investigation. Such investigations have been carried out and published in recent papers which have appeared in the *Proceedings* of the Indian Academy of Sciences. It emerges that all the atoms in the crystal have $(24\,p-3)$ modes and frequencies of vibration in common. $(3\,p-3)$ of these frequencies represent modes in which equivalent atoms in neighbouring cells oscillate with the same amplitudes and in identical phases, while for the remaining $21\,p$ frequencies, equivalent atoms in adjacent cells oscillate with the same amplitudes but with phases which may be the same or else opposite along one, two or all three axes of the lattice. This picture of the dynamical behaviour of the atoms in a crystal has important consequences for the subject of X-ray diffraction which we shall now proceed to consider.

5. A Classical Analogue

It is useful in the first instance to consider the position from a purely classical standpoint so that the consequences arising therefrom may be taken over into the quantum-mechanical treatment of the problem. We shall restrict ourselves here to a consideration of the $(3\,p-3)$ modes of vibration of the atomic nuclei in which the vibrations in the different cells of the crystal lattice are identical in all respects. In such a vibration it would follow that the stratifications of electron density in the crystal would not remain in fixed positions but would oscillate to and fro with the frequency equal to that of the mode of vibration concerned. An X-ray beam traversing such stratifications would continue to be reflected in the same direction as in the static case. But in consequence of the periodic motion of the stratifications (assumed to be of small amplitude), the reflected X-ray beam would now consist of three spectral components having frequencies respectively ν, $(\nu+\nu^*)$ and $(\nu-\nu^*)$, ν being the incident X-ray frequency and ν^* that of the oscillation of the lattice. The additional components arising by virtue of the oscillations may be regarded as Doppler shifts of frequency resulting from the movement of the stratifications normal to themselves. The amplitudes of the additional components would be determined by the ratio of the amplitude of the oscillations to the wave-length of the X-rays.

The above classical result translated into the language of quantum mechanics would mean that the incident X-radiation traversing the crystal may excite the characteristic vibrations of the lattice, and if such excitation actually occurs, the beam would be reflected in the same direction as in the absence of such excitation but with diminished frequency. If, on the other hand, the characteristic vibration is already present by reason of thermal agitation, the crystal may be de-excited and the incident X-radiation would then be reflected with increased frequency.

6. Infra-Red Activity and X-Ray Diffraction

It will be seen from the foregoing that the mechanism which can give rise to X-ray reflections of altered frequency is altogether different from the mechanism which results in the scattering of light with frequency shifts in crystals. In the latter case

it is known that a change in the inter-nuclear distances gives rise to a change in the optical polarisability of the elements of the structure and hence also to secondary radiations with altered frequency; the selection rules which determine whether a particular mode of vibration is or is not active in light-scattering are different from those which determine whether or not the same mode is active in infra-red absorption. In the X-ray problem, the shifts of frequency in the X-ray reflections arise from the periodic movements of the stratifications of the electron density associated with the nuclear oscillation. Hence, it may be expected that the excitation and the de-excitation of the lattice vibrations resulting from the passage of X-rays would appear in circumstances analogous to those in which infra-red absorption manifests itself. In other words, X-rays may be expected to excite or de-excite those oscillations of the lattice which are also infra-red active.

7. The Geometry of the X-Ray Reflections

In the foregoing we have assumed that the vibrations in the crystal structure appear in all the cells of the crystal lattice not only with the same frequency but also with identical phases. This is evidently a highly idealised situation, which when it actually exists indicates that the X-ray reflection with altered frequency would appear in precisely the same direction as that of unmodified frequency. The modes and frequencies of the lattice vibrations are determined by the interatomic forces which may be assumed to fall off rapidly in magnitude with increasing interatomic distances. Hence, a change of phase of the oscillations occurring progressively as we pass from cell to cell—provided it be small enough—would involve a relatively small change in the actual frequency of vibration. This would give rise to the possibility of observing X-ray reflections with a change of frequency even in settings of the crystal different from those in which the ordinary or unmodified reflections are observed. Such reflections may be regarded as arising from a forced oscillation of the lattice with slightly altered frequency and with the appropriate phases induced by the incidence of the X-radiation. In such circumstances the intensity of the X-ray reflection of altered frequency may be expected to fall off more or less rapidly as the setting of the crystal is altered from the setting needed for an ordinary reflection.

8. The Influence of Thermal Agitation

As already indicated, it necessarily follows that if X-rays can excite an infra-red active oscillation of the lattice, they can de-excite such an oscillation if it already exists and thereby give rise to an X-ray reflection of increased frequency. The relative intensities of the X-ray reflections with increased and diminished frequencies respectively would be determined by the Boltzmann factor for the particular frequency of the oscillation of the lattice. The reflections of increased and of diminished frequencies would, of course, appear in the same direction, and it is the summation of their intensities that would determine the observed effects. Accordingly, measurements of the variations in intensity of this observable effect with temperature would enable us to estimate the frequency of the vibrations responsible for them.

9. Summary

The quantum theory of dispersion indicates that the infra-red active vibrations of the atoms in a crystal would be excited by the passage of a beam of X-rays through it. Such excitation would result in the incident beam being reflected by the lattice planes of the crystal with appropriately diminished frequency. Such reflections would also be observable but with diminished intensity when the setting of the crystal is moved away from the position in which X-rays of the given wave-length are selectively reflected by the lattice planes in question with unaltered frequency. The effect of thermal agitation is also considered.

THE GENETIC EFFECTS OF ATOMIC BOMB EXPLOSIONS

J. B. S. HALDANE

Dept. of Biometry, University College, London

I SHOULD perhaps begin by defending myself for writing on this topic. I am not a physicist, still less have I any special knowledge on the physics of the atomic nucleus. Nor have I experimented on the artificial production of mutations, and very little work on this topic has been done under my supervision. On the other hand, twenty years ago Penrose and I were the first to calculate human mutation rates. And as it is feared that atomic bombs have caused, or will cause, increase in these rates, I have at least some claim to knowledge on this matter.

In the first quarter of this century it was found that a great many characters were inherited in accordance with Mendel's laws, though as early as 1902 Correns had discovered some which were not. The inheritance of the Mendelian characters has turned out to be explicable in terms of genes, which are believed to be small sections of chromosome, each responsible for a particular metabolic process, and usually copied very exactly at each cell division. By 1915 it was already known that this copying, or replication, process sometimes went wrong, so that a new gene appeared, and was then copied in its turn. The appearance of a gene of a new type is called mutation.

For example, the human X chromosome, of which women have two in each nucleus, whilst a man has only one, inherited from his mother, includes a small section which is concerned in making a particular globulin in the blood plasma. When this section is altered the globulin is no longer made, and the blood will only coagulate after a day which may last several hours. Persons lacking this globulin are called hæmophilics, and most of them die before puberty.

As a result of natural selection the abnormal gene causing hæmophilia would disappear in a few centuries if it did not constantly arise afresh by mutation. Of the genes responsible for making the anti-hæmophilic globulin, about one in 40,000 mutates in each generation, and a new pedigree of hæmophilia arises.

In 1927, H. J. Muller found that X-rays greatly increase the frequency of mutation of some of the normal genes in the small fly Drosophila. This has since been found to be true in other animals (including mice), many plants, and bacteria. Alpha particles, neutrons, and gamma rays have similar effects. In 1942 Auerbach and Robson proved what had been suspected for some time, that some chemical substances were also mutagenic. In 1955 Fahmy and Fahmy proved that one such substance caused genes in Drosophila to mutate which had never been known to mutate spontaneously or under the influence of X-rays.

The question then arises: "If a large number of human beings are exposed to abnormal amounts of high frequency radiation, what effects may be expected in their descendants?" The first point to be made is that everyone is exposed to a certain amount of high frequency radiation, especially from cosmic rays, and from the radioactive isotope of potassium. The mean dose per generation is about 3 roentgens, but it may be as high as 5 or 6 in high countries like Tibet where cosmic radiation is more intense, and in igneous areas like some of Southern India where the soil contains appreciable amounts of radioactive elements.

In *Drosophila melanogaster* it is fairly easy to measure the frequency of lethal mutations, that is to say, mutations which cause so great a change as to kill the flies in the egg or larval stage. Most such mutations are recessive. That is to say the abnormal gene is harmless or nearly so, provided the animal has received a normal gene from one parent. Occasionally we understand why this should be so. Thus normal human beings can oxidise phenylalanine to tyrosine with a very specific enzyme found in their liver cells. This enzyme is only formed if a normal gene is present in a cell nucleus. If neither parent contributes such a gene, the enzyme is not formed. The blood and cerebrospinal fluid contain large amounts of phenylalanine and oxidation products such as phenylpyruvic and phenyl-lactic acids, which are also excreted in the urine. The head is usually rather small, and a child unable to oxidise phenylalanine is always mentally backward and generally an idiot, dying fairly young. The abnormal gene, which does not produce phenylalanine oxidase, is handed down (by copying) for many generations in healthy people till two such people (heterozygotes for the gene) marry. Such marriages are particularly common between cousins, who may both have received the abnormal gene from a common ancestor.

Some recessive genes formed by mutation disappear by chance. Others spread by chance. But on an average, two such genes are only lost from the population as the result of a premature death, or a sterility.

Probably over 2% of all children born die before puberty as the result of such recessive genes, and many more die before birth. Now if we knew what fraction of human mutations is due to radiation we could calculate the effect of a given addition to the amount received. We do not know this. In *Drosophila melanogaster* most mutations are not due to radiation. But a human generation is about 500 times as long as a Drosophila generation. And a human nucleus contains about 30 times as much desoxyribonucleic acid (of which genes are probably composed) as a Drosophila nucleus. So the number of mutations produced by radiation in a human generation may be expected to be about 15,000 times as great as in the same number of Drosophilæ. It is therefore quite possible that most human mutations are due to radiation.

The amount of radiation needed to produce a lethal mutation in a *Drosophila melanogaster* is about 10,000 roentgens. More accurately about 1% of eggs or spermatozoa of flies exposed to 100 r. will carry a lethal mutant. About 4 times this number will carry a sublethal mutant causing serious abnormality. If man is 30 times as sensitive, the 3 roentgens received per generation should produce a lethal gene in about 1% of spermatozoa or ova and a sublethal in about 4%. Between them they would account for something like half or a third of the lethal and sublethal genes in human populations.

If we take the lower figure of one-third, this would mean that if the human race were permanently exposed to 10 r. per generation, the deaths and illnesses due to genetic causes would be about doubled. If, as I suppose, some kinds of mutation are not mainly due to radiation. some kinds of illness would be increased more than others.

Sir John Cockroft, in a recent article in *Nature*,[1] estimated the average increase in high frequency radiation at ground level due to the explosion of atomic bombs. Bombs such as were exploded over Japan had a negligible effect on the radioactivity at ground level beyond a few kilometres from the site of the explosion. Thermonuclear or "hydrogen" bombs contaminate the whole planet.

Cockroft states that enough radioactive elements have fallen and will fall on the surface of England to give "completely unprotected persons" a mean extra dose of about 0·03 r. He adds that as most people spend a good deal of time indoors, and brick houses give considerable protection, this dose is probably reduced to about a tenth on an average. This is very reassuring to British readers. But he did not add that most of the people in India spend a great deal of time out of doors, and their houses have very thin walls which give no serious protection against gamma radiation from outside.

It follows that if radioactive substances are spread fairly evenly all over the world, most of the harmful genetic effects will occur in countries like India, Pakistan, Indonesia, Tropical Africa and Brazil, where conditions are similar. I am sure that Sir John regrets this, but some persons associated with him may not do so. Thus Sir Ernest Rock Carling, official representative of the British Government at the recent Geneva Conference at which Dr. Bhabha presided, said, "In a world contemplating a future in which the expansion of its population may outrange its food supply, it is conceivable that diminished fertility and shortening of the life-span might not altogether be deplored". He might deplore these consequences even less if they were largely concentrated in tropical countries.

It is very hard to estimate the probable killing effect on Indians. But if we assume that about 15 crores of future Indian parents have been erposed to ·03 r., this gives a total dose of $4{\cdot}5 \times 10^6$ r. which might cause 15,000 lethal mutations and 30,000 or 40,000 sublethal. Most of them are recessive, so that we should expect one death for every two mutations if the population remains about its present level, but more if it increases, perhaps 30,000 deaths in all. These extra deaths will be spread over many thousand years, though the maximum incidence will probably occur in the next century.

The British Government is probably going to explode a hydrogen bomb in the next year or so. The Americans are reported to be about to explode two. The Soviet Union will probably follow their example. Although its government wishes to prohibit atomic bombs, it would presumably not accept the arguments of this paper, which are based on "Mendel-Morganism". These explosions, if they occur, may produce about as much more radioactivity as Sir John Cockcroft allowed for. Sonnenblick[2] estimates a mean dose for the human race of 0·2 to 0·3 r. I have based my calculations on a much lower figure to avoid alarmism.

India is the most important state in a position to protest against all such projects, and, as I have shown, it has special reasons for doing so. The Indian Government might also initiate experiments designed to estimate the probable effects. The figures which I have given are conjectural. They may be too high by a factor of ten or even more. They may also be too low. The experiments on mice whose results have been so far published in the U.S.A. were not so designed as to estimate the risk. They showed that some genes in mice were much more easily caused to mutate than genes in Drosophila, but they gave no estimate of the number of genes at risk. And one cannot safely argue from mice to men. But the risk to mice could be determined experimentally, and the effects of X-rays or gamma rays on human and mouse tissue cultures compared. The research could be done in India. I have worked out a scheme for the research on mice, but wish to discuss it with colleagues before publication.

I am quite aware that it is frequently stated that so many people die already from the effects of mutation that an increase by an extra few per cent. does not matter. Such an opinion does not coincide with my own ethical views. I venture to hope that these views are shared in India.

1. *Nature*, 1955, **175**, 873.
2. *Genetics*, 1955, **40**, 597.

CONFLICT *VS.* CO-OPERATION AS FACTORS IN EVOLUTION*

A SEGMENT of Acharya J. C. Bose's own philosophy of the "Unity of Life" forms the subject-matter of this Memorial Lecture. According to Bose, it is a misunderstanding of the Laws of Nature to regard conflict as the only factor in evolution; far more potent than competition is mutual aid and co-operation in the scheme of life. He had also pointed out that there must be unity of all human efforts and that in the realm of the mind there can be no boundaries and no separations. For, the evolutionary process has been active not only in morphological differentiation, that is, in the development of new forms, but also in physiological differentiation, that is, in the development of special mechanisms for performance of various vital functions. Thus every organ of a living being is an instrument subserving a particular function for the advantage of the organism.

The above views expressed by Bose as early as 1927 are not only very significant and important but prophetic when judged by the present-day urge for peace among the nations of the world through the adoption of the principles of *Panch Shila*. Modern development in the biological sciences would also tend to refute the Darwinian principles of evolution through random variations, competition, struggle for existence, natural selection and survival of the fittest, and lend support to evolution through the adjustment of organisms to the physicial and biological factors in their respective environments. Thus the principle of coexistence, in spite of varied conditions of life, is biologically sound for all living organisms, including the human race. Biological principles would only appear to lend support to the philosophy of Acharya Bose that "far more potent than competition is mutual aid and co-operation in the scheme of life".

* Abstract of the Seventeenth Acharya Jagadish Chandra Bose Memorial Lecture by Sunder Lal Hora.

INDIAN SCIENCE CONGRESS, FORTY-THIRD SESSION, AGRA

THE Forty-Third Session of the Indian Science Congress Association will be held at Agra during the week 2-8, January 1956, under the presidentship of Dr. M. S. Krishnan. The session will be inaugurated by the Prime Minister, Shri Jawaharlal Nehru.

Besides scientists from all parts of India, the following distinguished visitors from abroad are expected to attend the Congress: Prof. Martin Eichler and Prof. C. L. Siegel (W. Germany), Prof. B. A. Houssay (Argentina), Prof. M. H. Stone, Dr. D. W. Bronk and Dr. Robert Oppenheimer (U.S.A.) and Dr. J. H. Burn (U.K.).

A number of symposia have been arranged and an exhibition of instruments, apparatus and equipment will also be organised during the session.

INDO-PACIFIC FISHERIES COUNCIL

THE Sixth Session of the Indo-Pacific Fisheries Council (which is an Inter-Governmental organization of sixteen countries of the Indo-Pacific area) was held at Tokyo (Japan) from 30th September to 14th October 1955. The session was attended by delegations from all the member countries of the Council, *viz.*, Australia, Burma, Ceylon, France, India, Japan, Korea, Netherlands, Pakistan, Philippines, Thailand, U.K., U.S.A., and Viet Nam. Observers also participated on behalf of the UNESCO, South Pacific Commission, the World Meteorological Organisation, and International Commission for Scientific Exploration of the Mediterranean.

During the session, it was decided to observe Indo-Pacific Fisheries Years at regular intervals when attempts will be made for simultaneous collection of statistics relating to fisheries and other ancillary biological factors by the different countries in the Indo-Pacific region. The first Indo-Pacific Fisheries Year is proposed to be observed in 1957-58 to coincide with the International Geophysical Year. Various other proposals to increase the efficiency of the Council work during and between the sessions were discussed and formulated. Co-operative plans for research in India, Burma and Pakistan on the Hilsa fisheries were adopted at the session, as also steps taken to initiate such co-operative research on the mackerel (*Rastrelliger*) fisheries which is one of the most important marine fisheries of South and South-East Asia. A Symposium on Prawn Fisheries held along with the session and at which many specialists participated highlighted the great value of this sea fishery resource to the Indo-Pacific area. It was decided to hold an International Symposium on Fish Culture in Rice Fields during the seventh session of the Council.

India was represented on the Council by Dr. N. K. Panikkar, who also participated at the conclusion of the session in meetings convened by the UNESCO at Tokyo on Marine Sciences. Dr. Panikkar (India) was unanimously elected as Chairman and Mr. D. J. Rochford (Australia) as Vice-Chairman of the Council for the ensuing period. The next session of the Council will be held at Bandung in Indonesia in 1957 at the kind invitation of the Indonesian Government. A special meeting of specialists to draw up a co-operative programme on *Rastrelliger* is proposed to be held in Malaya in 1956.

NATIONAL MERIT SCHOLARSHIP PROGRAM, U.S.A.*

FORMATION of the National Merit Scholarship Corporation, Evanston, Ill., was announced on 6 September by its President, John M. Stalnaker. The Corporation is an independent, non-profit organization whose purpose is to devise and administer a nation-wide system of scholarships for higher education. The Ford Foundation and the Carnegie Corporation of New York have undertaken to finance the activity by providing grants totalling $ .25 million for its administrative expenses. The Ford Foundation has also appropriated a $ 10 million scholarship fund, payable at the rate of $ 1 million a year for 10 years, and is prepared to finance additional scholarships up to a total of $ 8 million. All Secondary Schools, public and private, are entitled to participate in the programme.

The major underlying purposes of these grants are twofold: to find the country's most talented young people and make a college education available to them regardless of their financial situation; and to make it easy for business enterprises to contribute effectively to the support of higher education. A further purpose is to provide, in one organization, a single programme that will reduce wasteful duplication of operation and expense and will, at the same time, protect fully the natural interests and purposes of the donors. The flexibility of the present programme provides this protection.

Beginning this fall, the more than 24,000 Secondary Schools of the nation will be invited to participate annually in the National Merit Schoalrship Programme. The selection will be made in a series of stages and finally, the highest for each state to the extent of five times the number of scholarships to be awarded, will be requested to supply further information with regard to school records, recommendations, and biographical information. Using all of this background material, the selection of the winners will be made.

It may be worthwhile to initiate a similar programme in our country for the recruitment of the best scientific talent.

* *Science*, 1955, **122**, 508.

A NEW METHOD FOR THE ESTIMATION OF NITROGEN IN CELLULOSE NITRATE

C. V. PADMANABHAN* AND S. SUNDARAM§

Dept. of Chemical Technology, University of Bombay, Bombay-19

THE two methods commonly employed for the estimation of nitrogen in cellulose nitrate are: (i) The Lunge Nitrometer method [1] and (ii) The alkaline peroxide digestion or the modified De Varda's method.[2] In the former method the nitrate groups are reduced to nitric oxide (NO) by the Hg-H_2SO_4 system which is then measured. In the latter method the cellulose nitrate is dissolved by digestion with alkaline hydrogen peroxide followed by reduction with De Varda's alloy. The ammonia formed is estimated as usual. The De Varda's method has been used by Davidson,[3] and Kenyon and co-workers.[4] However, it is well known that during the saponification of cellulose nitrate by alkali the nitrogen is partly converted into nitrite,[5] cyanide,[6] nitrogen[7] and ammonia.[8] Therefore it is likely that some loss of nitrogen may occur during the digestion in the second method even though the losses may be minimised on account of the presence of the hydrogen peroxide. With a view to overcome this difficulty, the method has been modified as follows: The sample is dissolved in concentrated sulphuric acid. This solution is slowly added to a strong solution of caustic soda in the distillation flask of the ammonia estimation apparatus. The mixture is then treated with De Varda's alloy and the ammonia formed estimated as usual. A number of samples of cellulose nitrate have been prepared and analysed for their nitrogen content by (i) Lunge's method, (ii) the modified De Varda's method, and (iii) the new method.

Experimental

Preparation of Cellulose Nitrate.—Carefully purified cotton yarn (2 g.) cut to small bits (< 1/16") is immersed[9] in a mixture (100 ml.) obtained by mixing 1 vol. nitric acid (sp. gr. = 1·52) and 2 vol. sulphuric acid (sp. gr. = 1·84) maintained at 0° C. At the end of the requisite period the cellulose nitrate is freed from the spent acid by filtration through a sintered glass filter. The nitrated sample is then plunged into a large volume of ice-cold water. The product is washed free from acid by repeated changes of water. The samples are dried by exposure to air and stored carefully.

Present Address:—* Bangalore Woollen, Cotton and Silk Mills Ltd., Bangalore 2.

§ Technological Institute of Textiles, Birla Colony, Bhiwani, E. Punjab.

Analysis of Cellulose Nitrate Samples

1. *Lunge's Nitrometer Method.*—A Lunge Nitrometer calibrated to 50 ml. in 1/10 ml. is used. The nitrometer is filled with clean mercury. About 100 mg. of the sample is accurately weighed out into the cup of the nitrometer. It is then dissolved by the addition of 10 ml. of pure nitrogen-free concentrated sulphuric acid. The solution is then carefully drawn into the nitrometer without drawing in any air. The cup is then rinsed with two or three 2 ml. portions of pure sulphuric acid. Each lot of the acid is drawn into the nitrometer before the next lot is added. The apparatus is then vigorously shaken so that the mercury and the acid are mixed thoroughly. After allowing the apparatus to come to room temperature the pressure of the gas in the nitrometer is brought to atmospheric by raising or lowering the levelling tube. After the volume is measured the nitrometer is vigorously shaken again and the volume of gas at room temperature and pressure measured. Usually there is no change in volume.

2. *Modified De Varda's Method.*—100 mg. of the sample is accurately weighed into a Kjeldahl flask. Then 2-3 ml. of ethyl alcohol, 20 ml. ammonia-free distilled water, 5 ml. 25-30% H_2O_2 and 4 ml. of 40% caustic soda solution are added. The flask is then heated on a steam-bath till the sample is dissolved. It has been noticed during the course of the present investigation that lower the nitrogen content of the sample the longer is the time required for digestion. The excess of hydrogen peroxide is destroyed by heating on a steam-bath till effervescence ceases. The flask is then cooled to room temperature and 15 ml. of 40% caustic soda solution and 100 ml. of ammonia-free distilled-water added. 1·5 g. (60 mesh) De Varda's alloy is then added to the mixture and the flask immediately connected to the ammonia distillation train. When the hydrogen evolution has ceased (30 min.) the contents are boiled and the ammonia evolved is estimated by absorption in standard hydrochloric acid (50 ml. of 0·04 N) containing 10 drops of the mixed indicator[10] and backtitrating the excess acid with carbonate-free 0·04 N sodium hydroxide from an automatic burette fitted with soda line traps. A blank is carried out with the reagents used. The mixed indicator[10] is prepared by mixing

2 ml. of aqueous methylene blue solution (1%) with 100 ml. of 0·04% solution of methyl red in 50% alcohol. The change at the end point is from pink through grey to green and is quite sharp. A blank is also carried out with the reagents used.

3. *The Proposed Method.*—100 mg. of the sample is accurately weighed and dissolved in 5 ml. of pure nitrogen-free sulphuric acid. The solution is neutralised by slow addition through a dropping funnel to a mixture of 30 ml. of 1 : 1 caustic soda solution and 100 ml. of ammonia-free distilled-water in the distillation flask which is connected to the ammonia distillation train. The funnel is then washed down with two or three 2 ml. portions of pure sulphuric acid, two 50 ml. portions of ammonia-free distilled-water and 5 ml. of ANALAR ethyl alcohol. The solution in the flask is pale yellow or practically colourless. De Varda's alloy (1·5 g., 60 mesh) is introduced into the distillation flask through a side tube which is immediately stoppered. The evolution of hydrogen is complete in about half-an-hour. The solution is then raised to boil and the distillation continued for half-an-hour. All the ammonia distils were over within this time. The ammonia that distils over is estimated as described previously. A blank is also carried out with the reagents used.

The results are given in Table I. From the results it can be seen that the proposed method gives values in close agreement with those obtained by the Lunge's method. It is also evident that the modified De Varda's or the alkaline peroxide digestion method gives consistently lower values.

TABLE I

Estimation of nitrogen in cellulose nitrate. The numbers given are the percentage of N, found as an average of three measurements in each case

Sample number	Lunge's method	Modified De Varda's method	Proposed method
1	8·71	8·23	8·76
2	10·5	9·85	10·46
3	11·23	10·16	11·2
4	12·46	11·56	12·43
5	12·86	12·43	12·93

1. *The Methods of Cellulose Chemistry*, C. Dorée, 1947 edn., Chapman and Hall, p. 244.
2. —, *Ibid.*, pp. 247–48.
3. G. F. Davidson, *J. Text Inst.*, 1938, **29**, 198T.
4. W. O. Kenyon and Co-workers, *J. Amer. Chem. Soc.*, 1947, **69**, 342.
5. W. O. Kenyon and H. LeB. Gray, *Ibid.*, 1938, **58**, 1422.
6. W. Will, *Ber.*, 1891. **24**, 400.
7. C Hausserman, *Chem. Ztg.*, 1905, **29**, 421.
8. A. Bechamp, *Compte Rendus*, 1855, **41**, 817.
9. I. Sakurada, *Celluloschem.*, 1934, **15**, 18; see also *Cellulose Chemistry*, E. Heuser, 1944 edn., p. 184, John Wiley.
10. A. C. Andersen and B. N. Jensen, *Z. Anal. Chem.*, 1931, **83**, 114.

ATOMIC WASTE PRODUCTS

THE probable increase in the number of atomic power plants within the next few years poses a serious problem to the industry. That is the disposal of the radioactive materials which are produced in the reactors.

One proposed method is to enclose it in large concrete blocks and drop it into the ooze at the bottom of the deepest part of the ocean. By the time the concrete is worn away, thousands of years would elapse and the radioactivity would have decreased to almost zero. But some experts feel that there may be strong currents in the sea at great depths, so the concrete would be worn away more rapidly and the radioactivity would be released; it would thus find its way into plants and fish and become dangerous as human food. On the other hand, even if this happened, the radioactivity would concentrate only in the bones and scales of the fish, which are not used as food.

Another suggested method of disposal is to bury these materials under heavy concrete in deep abandoned mines or even in deep natural caves. This would be safe enough except that explorers and archæologists centuries into the future might unsuspectingly encounter their rays. The strangest suggestion was made by an American professor who proposed that these materials should be loaded into a space rocket and sent permanently far from the earth, cruising through the remote regions of the universe like a lost star!

It was agreed at the United Nations Conference on the Peaceful Uses of Atomic Energy in Geneva that the problem *must* be solved, and that meanwhile scientists and governments should make certain, probably by international action, that proper precautions are always taken for the disposal of radioactive waste.

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SPECIFIC HEAT AND ENTROPY OF LIQUID He³

The specific heat of liquid He³ has been measured by Roberts and Sydriak[1] in the temperature range 0·54° K to 1·7° K. Their results are in general agreement with the data of other workers.[2,3] The purpose of this note is to suggest an equation for the specific heat-temperature curve which fits with the experimental values,* and to obtain from it an equation for the entropy of liquid He³ using the thermodynamic relation $S = \int \frac{C}{T}\, dT$.

Assuming the atoms of He³ in the liquid to behave as an ideal degenerate Fermi-Dirac gas, in which phonon excitations are possible, the specific heat C can be expressed as a sum of a linear term and a cubic term in temperature T, *i.e.*, as

$$C = A + BT + CT^3 \text{ cal deg}^{-1} \text{ mole}^{-1} \quad (1)$$

where the constant A appears to yield the observed value of C at any particular temperature. For best fit the constants are found to be $A = 0{\cdot}670$, $B = 0{\cdot}288$, and $C = 0{\cdot}078$. In Table I are collected the observed values of

* During the publication of this note the paper of Roberts and Sydoriak (*Phys. Rev.*, 1955) 1672, 98, has appeared in which the suggested equation has been used with different values of constants.

specific heat by Roberts and Sydoriak[1] and the values calculated from (1).

TABLE I

Specific heat of liquid He^3 in cal deg^{-1} mole^{-1}

T° K	Ref. 1	Calculated (1)
0·540	0·83	0·838
0·629	0·89	0·871
0·748	0·92	0·918
0·804	0·92	0·942
0·872	0·98	0·993
1·069	0·06	1·073
1·157	1·12	1·124
1·251	1·22	1·183
1·256	1·19	1·200
1·364	1·25	1·261
1·453	1·35	1·328
1·528	1·44	1·389
1·609	1·46	1·458
1·695	1·54	1·538

The entropy of liquid He^3 when derived from (1) reads:

$$S = A \ln T + BT + C/3\, T^3, \text{ for } T > 0{\cdot}5^\circ K \quad (2)$$

From the above equation the correct value of S at any particular temperature is obtained by setting $S = 2{\cdot}09$ cal deg^{-1} mole^{-1} at 1° K, i.e., the value calculated by Weinstock, Abraham and Osborne[4] from the vapour pressure data. Then (2) becomes

$$S = 1{\cdot}776 + 0{\cdot}670 \ln T + 0{\cdot}288\, T + 0{\cdot}026\, T^3 \text{ cal}^{-1} \text{ deg mole}^{-1} \quad (3)$$

As shown in Table II, the calculated values of S from (3) are in close agreement with the results of Weinstock, Abraham and Osborne[4] over a large range of temperature.

TABLE II

Entropy of liquid He^3 in cal deg^{-1} mole^{-1}

T° K	Ref. 4	Calculated (3)
0·5	..	1·459
1·0	2·09 ± ·14	2·090
1·5	2·50 ± ·17	2·567
2·0	3·00 ± ·22	3·040
2·5	3·66 ± ·29	3·548

Physics Dept., Allahabad University, Allahabad, *September* 10, 1955.

BIPIN KUMAR AGARWAL.

1. Roberts, T. R. and Sydoriak, S. G., *Phys. Rev.*, 1954, **93**, 1418.
2. De Vries, G. and Daunt, J. G., *Ibid.*, 1953, **92**, 1572; 1954, **93**, 631.
3. Osborne, D. W., Abraham, B. M. and Weinstock, B., *Ibid.*, 1954, **94**, 202.
4. Weinstock, B., Abraham, B. M. and Osborne, D. W., *Ibid.*, 1953, **89**, 787.

A NOTE ON THE BOILING POINTS OF REGULAR SOLUTIONS

GUGGENHEIM[1] has shown that the thermodynamic properties of binary liquid mixtures, which deviate only slightly from ideality, can be determined from the quasi-crystalline model proposed by him. The application of this model to the evaluation of the interchange energy requires very accurate experimental observations on the thermodynamic properties of binary mixtures of liquids which very nearly satisfy the conditions for regular solutions.

The partial vapour pressures p_A and p_B and the molar heats of mixing $\Delta_m H$ of regular solutions are given by the relations:

$$\left.\begin{aligned} & p_A = p_A^0\, x e^{\frac{\omega}{kT}(1-x)^2};\ p_B = p_B^0\,(1-x) e^{\frac{\omega}{kT}x^2} \\ \text{and} \\ & \Delta_m H = x\,(1-x)\,Nu;\ u = \omega - T\left(\frac{d\omega}{dT}\right) \end{aligned}\right\} \quad (1)$$

where p_A^0 and p_B^0 are saturated vapour pressures of the pure components A and B respectively at temperature T° K, x, the mole fraction of the component A in the mixture and ω, the interchange free energy.

Some data are available (Porter[2]; Zawidzki[3]; Scatchard[4]) for the partial vapour pressures of binary liquid mixtures. However, due to experimental difficulties involved, these determinations are beset with uncertainties. The only measurements of sufficient accuracy, suitable for comparison with the *quasi*-lattice theory, available upto this time are those of Scatchard[4] on mixtures of benzene/carbon tetrachloride and cyclohexane/carbon tetrachloride. Recently accurate measurements of the heats of mixing of the above two systems have been made by Cheesman and Whitaker[5] and Adcock and McGlashan.[6] Their results are in good agreement with theory.

We have been exploring the suitability of the available data of the boiling points for comparison with the *quasi*-lattice theory and the evaluation of the thermodynamic properties of various regular binary mixtures with reasonable accuracy. This note deals with the boiling points of benzene/carbon tetrachloride mixtures.

If we consider the mixture as an ideal solution, the total vapour pressure of the mixture at any temperature T can be written as

$$p_t = p_A^0 x + p_B^0\,(1-x) \quad (2)$$

where p_t is the total vapour pressure of the mixture, and A and B stand for benzene and carbon tetrachloride respectively. The saturated vapour pressures of benzene and carbon

tetrachloride are given by the relations of the type

$$\log_{10} p_{mm} = -\frac{\alpha}{T} + \beta$$

Using Young's values[7] of the constants in the above equation for benzene and carbon tetrachloride in the temperature range 76-80° C., we have computed numerically the temperatures at which the total vapour pressure of the mixture becomes one atmosphere (*i.e.*, the boiling points of the mixtures under atmospheric pressure) for different composition of the mixtures. The broken line (*a*) in Fig. 1 shows the variation of boiling points of the mixture with composition obtained from equation (2).

On the *quasi*-crystalline model the total vapour pressures are given by

$$p_t = p_A^0 x e^{\frac{\omega}{kT}(1-x)^2} + p_B^0 (1-x)\, e^{\frac{\omega}{kT} x^2} \qquad (3)$$

The full line curve (*b*) in Fig. 1 shows the variation of boiling points with composition obtained from relation (3) using Young's data for p_A^0 and p_B^0 and Scatchard's value for ω.

$$\omega = 71{\cdot}8 \text{ cal/mole at } 70° \text{ C.}$$

and

$$\frac{d\omega}{dt} = -0{\cdot}15 \text{ cal/deg mole.}$$

The curve (*b*) obviously represents accurate boiling points since Scatchard's values of ω are known for their great accuracy in representing the partial pressures of benzene/carbon tetrachloride mixtures. Observed experimental boiling points of the same mixtures are shown by triangles in Fig. 1. Excellent agreement between the experimental and calculated points is noticed.

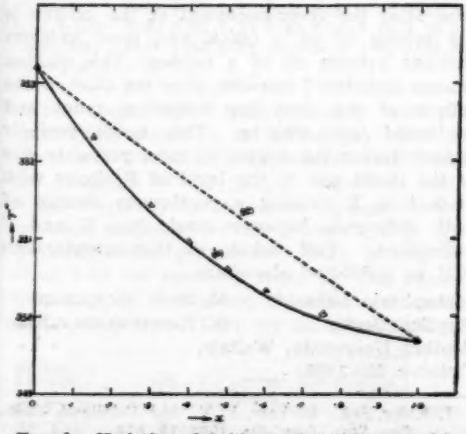

FIG. 1. Variation of boiling point with composition in mixtures of benzene and CCl_4. x is the fraction by weight of CCl_4. Curve (*b*) is obtained from Eqn. (3), while the triangles are the experimental points.

These considerations show that these boiling point measurements can be used to evaluate the interchange energy and hence thermodynamic properties of regular solutions with reasonable accuracy. It is thus possible to extend the *quasi*-crystalline model to regular solutions for which neither partial pressures nor heats of mixing of sufficient accuracy are still available. It would be interesting to compare the molar heats of mixing thus obtained with those directly determined from experiments whenever such data becomes available. Experimental determination of molar heats of mixing for different regular mixtures is being taken up.

Our thanks are due to Professor D. S. Kothari for his interest in these investigations.

Dept. of Physics, P. K. KATTI.
University of Delhi, O. P. RUSTGI.
October 7, 1955.

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DIPOLE MOMENT OF 2:4 DINITROFLUOROBENZENE

THE dipole moment of 2 : 4-dinitrofluorobenzene is calculated using the method previously given by the author[1,2] assuming the moments of the monosubstituted compounds as $m_{c1} = 1{\cdot}45$ and $m_{c2} = 3{\cdot}90$[3]. The value of 3·56 D so obtained is in good agreement with the experimental value of 3·55 D observed in solution in benzene at 30° C. The dielectric constants are measured at a frequency of 1 Mc/s. using a resonance method of the type described by Le Fevre and Russel.[4]

Full details will be published elsewhere.

Physics Dept., D. V. G. L. NARASIMHA RAO.
Andhra University,
Waltair, *October* 19, 1955.

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EFFECT OF SOLAR ECLIPSE OF 20TH JUNE 1955 ON LONG DISTANCE SHORTWAVE TRANSMISSIONS

STUDY of the Ionosphere during a solar eclipse is an important means of ascertaining the source of ionising radiation on the solar disc. With a view to study the effects of the solar eclipse of 20th June 1955 on the Ionosphere, field strengths of C.W. transmissions from Radio Ceylon (distance 1,300 Km.) on 9·52 Mc/sec. were recorded at Waltair (Lat. 17° 41′) during the eclipse day and a few days before and after the eclipse using Hallicrafters type SX-42 receiver with a D.C. amplifier and a pen-recording equipment.

The eclipse was total at Colombo. The first hop reflection point falls at about Madras where the beginning of the eclipse is reported to be at 0711 hr. (I.S.T.). The maximum phase of 86% was reached at 0816 hr. and the end was at 0930 hr. Records were taken in the morning hours between 0700 to 1000 hr. and also during night time with the same setting of the gain controls so as to get the reference signal strength when it is at its maximum. The average of signal strength received on days other than the eclipse day are plotted against time and is shown in Fig. 1. The night value of signal strength is also shown as a reference level. The values of the signal strength obtained on the day of eclipse are plotted on the same graph.

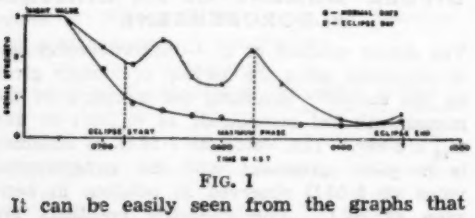

FIG. 1

It can be easily seen from the graphs that the signal strength on the eclipse day is about 30% higher than the normal value even at 0700 hr. when the optical eclipse has not started. It appears from this record that the effect on the absorbing layer is felt even before the optical eclipse started probably because of the eclipsing effect on the Corona which sets in earlier.

A peculiar feature observed in this record is the strong dip of signal strength at about 0800 hr. A strong maximum in the signal strength is noticed at 0816 hr. which is the time of maximum phase of the eclipse. The signal strength at this time is about 4·5 times the value that is usually observed in the normal days at that time. The intensity is about 72% of the night value. A rapid fall of the intensity reaching almost the normal value at about 0900 hr. was observed although the ending of the eclipse is at 0930 hr.

Many of the previous investigators[1,2] observed a definite decrease of ionisation densities of both E and F_1 layers during the solar eclipse. Using highly oblique incidence C.W. transmissions during solar eclipse some of the previous investigators observed a rise of signal strength[3] and some others[2] observed a fall of the same. This controversy indicates that the non-deviative D-region absorption has only a little role in causing the above changes of signal strengths.

The fall of signal strength during morning hours in the normal days is due to the growth of E layer ionisation which tends to obscure the F_1, F_2 reflections as judged from the critical frequency data for this month. But during the eclipse period due to the fall of E layer ionisation F_1 and F_2 reflections will be predominant along with the single hop E reflection and this causes considerable rise in the signal strength. Part of this rise in signal strength might have also been contributed by decrease in D-region absorption. The dip of the signal strength at about 0800 hr. is very probably due to the passage of a sporadic E cloud across the propagation path as in the summer month of June the frequency of occurrence of E_s with $f_s E_s$ between 3 Mc/sec. and 5 Mc/sec. is as high as 25 days in a month at this time as reported from Ahmedabad Ionosphere station.

Another interesting feature of this record soon after the commencement of the eclipse is the setting in of a quick and most uniform periodic pattern all of a sudden. This sudden change occurred 7 minutes after the start of the eclipse at the first hop reflection point and continued upto 0900 hr. This quick periodic fading during the eclipse is most probably due to the rapid rise in the level of F_1 layer with respect to E causing a continuous change of path difference between single hop E and F reflections. Full details of this investigation will be published elsewhere.

Ionospheric Labs., M. S. V. GOPALRAO.
Physics Dept., B. RAMACHANDRA RAO.
Andhra University, Waltair,
October 20, 1955.

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DIELECTRIC PROPERTIES OF AMINES AND METHYLENE CHLORIDE AT 3·38 CM.

THE electric susceptibility of ten organic molecules at some frequencies in 3 cm. range has been measured in this laboratory and has been reported. Improvement has been made in the previous technique,[1-3] thereby increasing the sensitivity considerably. In this improved technique the microwave radiations are modulated by 20 Kc/s. sine waves. The detected power is amplified by tunable indicating amplifier and fed to a.c. meter which measures the power. The diagram below shows the improved technique for measurement of electric susceptibility.

The electric susceptibility of a number of amines [CH_3NH_2, $(CH_3)_2NH$, $C_2H_5NH_2$, $(C_2H_5)_2NH$] and methylene chloride (CH_2Cl_2) has been measured by the improved technique. All the chemicals were obtained in the pure form and were passed through dehydrating tower before entering the waveguide cell. The values are shown in Table I.

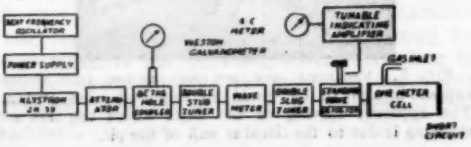
TABLE I

Variation of dielectric constant with pressure

(Tde wave-length of the radiation was 3·38 cm. The table lists the values of ϑ, the electric susceptibility and is expressed in units of 10^{-3}; temperature 31° C.)

Gas	Pressure in cm. of Hg							
	10	20	30	40	50	60	70	Atm.
CH_2Cl_2	0·86	1·56	2·25	..	..	..	..	..
CH_3NH_2	0·55	1·37	1·71	2·27	2·90	3·46	4·04	4·42
$(CH_3)_2NH$	0·40	0·86	1·32	1·80	2·30	2·78	3·28	3·51
$C_2H_5NH_2$	0·76	1·48	2·20	2·97	3·74	4·41	5·13	5·42
$(C_2H_5)_2NH$	0·69	1·22	..	..	..	..	..	..

It is found that ϑ varies linearly with pressure. The result is in conformity with Van Vleck and Weisskopf's expression[4] for ϑ, under the condition $|\bar{\nu} - \bar{\nu}_0| \gg \overline{\Delta\nu}$, where $\bar{\nu}$ (cm.$^{-1}$) is the resonant frequency of the molecule and $\overline{\Delta\nu}$ is the half-width parameter. This is the case when $\bar{\nu}$ is far removed from $\bar{\nu}_0$. The resonant frequency of methylene chloride and methyl amine are known. They are all above 20 Kmc/s.



In other cases we can conclude that the resonant frequency is far removed from 3·38 cm. at which observations have been made.

I am thankful to Shri Krishnaji, for his guidance and to Dr. Prem Swarup and Shri Shanker Swarup for their help in the work. Thanks are also due to the Council of Scientific and Industrial Research for financial assistance.

Dept. of Physics, G. P. SRIVASTAVA.
University of Allahabad,
Allahabad, *October* 27, 1955.

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SPECTROGRAPHIC ANALYSIS OF SOILS IN THE COPPER ARC

CARBON electrodes are often used for the estimation of most of the micro-elements in soils.[1] The determination of boron, however, presents a special problem requiring the use of copper electrodes as boron forms an impurity which cannot be easily removed from carbon. While standardising the technique for the estimation of boron in soils, it was thought desirable to find the possibility of estimating along with it a few other important micro-elements, namely, manganese and zinc. Preliminary results obtained by the method where pre-chemical treatment of the samples is avoided are recorded below.

Thirty milligrams of the soil sample finely ground in an agate mortar were added to an equal amount of pure aluminium oxide to which 1·09% of bismuth and 1·86% of cadmium were added as internal standards. The components were thoroughly mixed before filling the material in the electrodes. Copper rods (J.M.) 5·0 mm. diameter were shaped at the top 3·0 mm. into 2·5 mm. diameter and a cavity of 1/16" diameter and 3·0 mm. depth was made in it. The sample was filled in the cavity of the electrode (cathode) and arced at a current of 5·0 amperes using 220 volts D.C. Stepped spectra were recorded on Ilford 'Chromatic' plates using Hilger's Automatic Large Quartz Spectrograph. The plates were developed in a constant temperature-bath at 18° C. Intensities of the lines were measured using a non-recording microphotometer and proper background corrections were made.[2] Using the working curves drawn (almost straight lines), boron and manganese could be estimated down to 5 p.p.m.

and 30 p.p.m., respectively while zinc could not be estimated below 100 p.p.m., though their detection limits are much lower, namely, 1-2, 20 and 50 p.p.m. respectively. Recoveries of these elements added to the synthetic soil of the composition SiO_2 61·0%, Al_2O_3 19·4%, Fe_2O_3 4·8%, Na_2CO_3 3·4%, K_2CO_3 2·7%, CaO 1·9%, $MgSO_4$ 5·8%, TiO_2 1·0%, are given in Table I. Average of duplicates usually closely agreeing were taken. The wave-length of the lines used are given in brackets.

TABLE I

Recovery of micro-elements added to synthetic soil

Micro-elements	Internal Standard	Content of Manganese in p.p.m.	
		added	recovered
B (2497·7 Å)	Bi (2898·0 Å)	223	228
		46	45
Mn (2794·8 Å)	Bi (2898·0 Å)	208	210
		66	70
Zn (3345·0 Å)	Cd (3403·6 Å)	208	220

Manganese status of different samples of soil as estimated by this method is compared with the values obtained using chemical method in Table II. Values recorded are results of single determinations.

TABLE II

Manganese content in soil samples as estimated by spectrographic and chemical methods

Soil sample No.	Content of Mn in p.p.m. obtained by	
	Spectrographic method	Chemical method*
1	1480	1360
2	1320	1200
3	950	860
4	750	720
5	925	870
6	560	609
7	607	642

* The first five values were worked out by Shri O. P. Dhameja and the last two by Shri R. K. Chatterji and Dr. N. R. Datta Biswas.

The results recorded indicate that within 10% variation there is agreement between the spectrographic and chemical methods of estimation. In most of the Indian soils, as the manganese and boron contents are much higher than the lower limits of estimation, the copper arc method developed is being used as a rapid routine method of analysis in this laboratory. Zinc could be detected in soils only at a level of 300 p.p.m. using the cathode layer arc technique while the anode excitation method[3] made the detection possible at a level of 30 p.p.m. The results recorded in the present investigation compare very favourably with those obtained by anode excitation. Further work on the possibility of using this technique for the estimation of other elements is in progress.

The authors record their grateful thanks to Dr. B. P. Pal and to Dr. S. P. Raychaudhuri for their interest in the progress of the work.

Indian Agric. Res. Inst., New Delhi, *October* 22, 1955.

S. C. MEHTA.
C. DAKSHINAMURTI.

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V-SHAPED STRUCTURES IN THE JHIRI SHALES*

THE Jhiri shales of the Rewa series together with the other beds of the Vindhyan System in Bundelkhand are practically horizontally bedded sediments. They are devoid of any more complex structural features, even gentle folds or steep dips being altogether absent. However, in the open-cast pits of the Shahidan diamond mine near Panna in Vindhya Pradesh some peculiar V-shaped structures are seen in these shales. These are confined to

FIG. 1. V-shaped structure seen in the Jhiri shales exposed in a pit in the Shahidan diamond mine, Panna. The apparent curving of the beds where the men are standing is due to the circular wall of the pit.

the top layers of the formation and go down only a few feet from the surface. From a casual glance they appear like vertical isoclinal synclines (Fig. 1), but a close inspection reveals that they are not folds but are actually wedge-shaped vertical depressions or cracks in the otherwise horizontal sediments. In transverse section (Fig. 2) it is seen that the shale

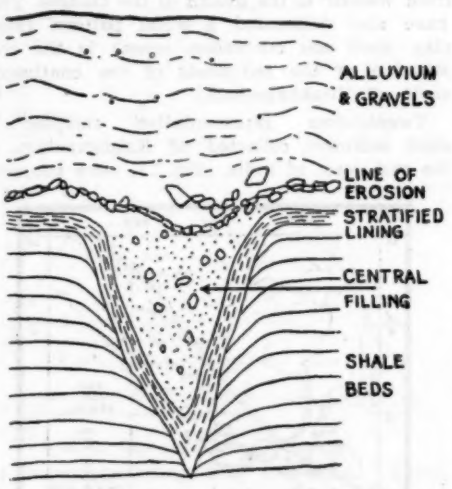

FIG. 2. Diagrammatic sketch of a cross-section of the fully developed crack shown in Fig. 1. It shows the horizontal shale turning slightly downwards adjacent to the crack, stratified lining layer, and unstratified central filling of alluvium, gravel and rock boulders.

laminæ tend to turn slightly downwards adjacent to the depression, which has a stratified lining that appears to be the folded portion of the topmost shale layers and gives the impression of a syncline. This lining is generally less than a foot in thickness, while the depression is generally 10 to 12′ deep but sometimes much less. The top of the structure is 5 to 8′ wide, and the depression is filled with unstratified alluvium, gravel and boulders. The soil mantling this formation is also somewhat stratified and gently undulating.

Paterson[1] and Leffingwell[2] have studied similar structures which they ascribe to *frost action* in Arctic climate. The same mechanism probably has also given rise to these cracks in the Jhiri Shales. They do not appear to be folds formed by moving ice as suggested by Ahmad.[3] They are also unlike similar cracks formed by desiccation in hot climates, which, according to Smith,[4] are narrow in proportion to depth and the wall rocks do not show any marginal distortion.

I am thankful to my colleague Mr. B. N. Raina with whom I have profitably discussed this note.

Northern Circle, S. M. MATHUR.
Geological Survey of India,
Lucknow, *August* 18, 1955.

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* Published by permission of the Director, *Geological Survey of India.*

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ORIGIN OF INDIALITE (CORDIERITE) BEARING AND OTHER VITROPHYRIC AND HORNFELSIC ROCKS

A. MIYASHIRO AND T. IIYAMA[1] have discovered a new hexagonal mineral in the "fused sediments (so-called para-lava)" of Bokaro Coalfield, India $(Mg\ Fe^{++})_2\ Al_4Si_5O_{18}$ in composition polymorphic with cordierite. This mineral has been identified hitherto as cordierite, but the X-ray analyses led them to identify it as a new mineral and they have proposed the name "indialite" to it. Similar indialite-bearing vitrophyric and hornfelsic rocks have been observed at the contact of mica-lamprophyre intrusions by the authors of this note at many localities in the Jharia and Raniganj Coalfields, but two localities have been particularly chosen, one along the XIV seam, Chasnala Colliery, Jharia Coalfield and another along the Ramnagar seam, Victoria West Colliery, Raniganj Coalfield, because the geological setting of these vitrophyric and hornfelsic rocks are interesting from the point of origin.

At Chasnala area the indialite-bearing and plagioclase-bearing vitrophyric and hornfelsic rocks are closely associated with the burnt shale due to recent outcrop coalfire and occur adjacent to a mica-lamprophyre sill. In the Victoria West Colliery, the indialite-bearing vitrophyric and hornfelsic rocks occur as xenoliths in the mica-lamprophyre (peridotite) sill at the 14th level (684·75′ below surface level). The water-table in this mine occurs below a depth of 50′ from the surface. In these vitrophyric and hornfelsic rocks, indialite is often associated with sillimanite, tridymite and spinel. The form, twinning and optical properties of this mineral have been described in detail by Venkatesh[2] and P. R. J. Naidu[3] who have termed this mineral as cordierite. In a preliminary

paper contributed to the Indian Science Congress, the authors of this note[4] also identified this mineral as cordierite. The indialite-bearing vitrophyric and hornfelsic rocks are probably more basic than the associated shales, as can be seen from their mineralogical composition. None of the burnt shales due to recent outcrop coalfire at Chasnala Colliery contain indialite.

The origin of the indialite-bearing vitrophyric and hornfelsic rocks was attributed to the burning of coalseams at their outcrops by forest fires by Fermor[5] and later by Chatterjee and Ray.[6] They considered that these rocks are 'para-lavas'. Sharma and others[7] opined that these vitrophyric and hornfelsic rocks have formed due to some intermingling of the fused shaly rocks and mica-lamprophyre. The geological setting of the indialite-bearing vitrophyric and hornfelsic rocks adjacent to the mica-lamprophyre sills in the Jharia and Raniganj Coalfields, the universal occurrence of indialite in the vitrophyric and hornfelsic rocks, the absence of this mineral in the burnt shales due to recent outcrop coalfire and the occurrence of these rocks very much below the water-table have led the authors of this note to suggest that the origin of these rocks is more likely due to the metamorphism and metasomatism that the pelitic sediments have undergone at the contact of the mica-lamprophyre sills. It is difficult for the authors to decide at this stage which of the three process, namely, basification during reciprocal reaction or metamorphic differentiation or metamorphic segregation, operated in the origin of the indialite-bearing vitrophyric and hornfelsic rocks.

The authors wish to express their grateful thanks to Bengal Coal Co., Ltd., for affording permission and facilities to study the underground geology of the Victoria West Colliery.

Dept. of Geology, Indian School of Mines & Applied Geology, Dhanbad, *August* 25, 1955.

M. S. SADASHIVAIAH.
Y. K. AGRAWAL.

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MARINE SEDIMENTS OFF KALINGAPATAM ON THE EAST COAST OF INDIA

In their studies on marine sediments off the east coast of India, Mahadevan and Poornachandra Rao[1] observed that sillimanite, zircon, monazite, garnet and green pyroxene are the major heavy mineral components in sediments from Waltair to the mouth of the Ganges. They have also delineated a zonal pattern (sand, clay, shell and concretion zones) in the constitution of the sediments of the continental shelf off Visakhapatnam.

Twenty-four representative samples of shelf sediment collected off Kalingapatam, on the east coast of India (Fig. 1), were subjected

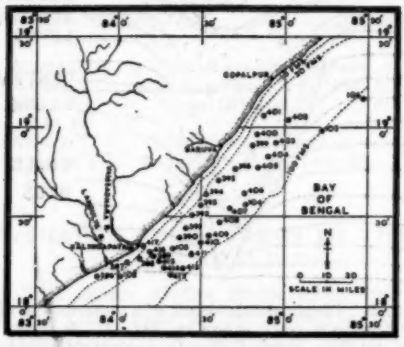

FIG. 1. Location map of sampling stations.

to detailed examination including mechanical analysis, heavy mineral studies, and determination of carbonate content. It is found their size distribution and mineralogical constitution are markedly different from those samples collected from similar depths in other areas.

Size Distribution.—A trilinear diagram[2] of all sediments, using as the three poles, (i) material finer than 0·063 mm. (silt and clay), (ii) material between 0·25 and 0·063 mm. (fine sand), and (iii) material coarser than 0·25 mm. (medium sand and granules) divides these sediments into five classes as illustrated in Fig. 2.

The very fine-grained silty sands of reddish hue from depths of 5-20 fathoms opposite Kalingapatam form a well-defined group (Class A, Fig. 2) and fall along that side of the triangle representing the absence of coarse particles, the mud content increasing with depth. North of Kalingapatam these sediments show a progressive change in both colour and particle size distribution. There is decrease in the percentage of silty sands with correspond-

ing increase in coarse-sand percentage, with the result that they fall just outside the zone of Class A sediments. Samples collected at depths of 20-40 fathoms constitute a separate group (Class B) occupying the central triangle formed by the 20% lines. Deep water sediments from depths between 40-60 fathoms are grouped under Class C and they occur along

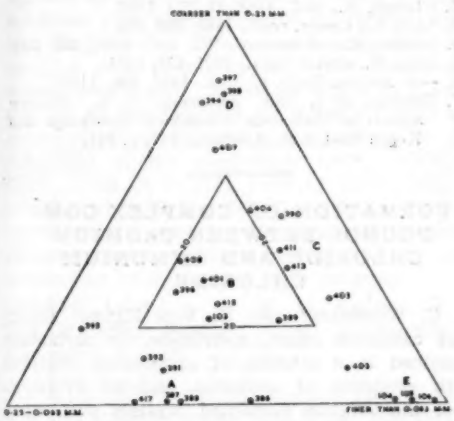

FIG. 2. Size composition of samples.

that line representing 20% fine sand. These samples contain more than 65% shells by volume of the total. Beyond depths of 60 fathoms occur grey-coloured plastic clays and these constitute a group (Class E) by themselves. The very coarse sediments from two isolated patches comprising 394 and 407* and 397 and 398 respectively form a well-defined and non-overlapping group (Class D). These consist very largely of coarse sand with some silty sand and very little clay.

Mineralogical Composition.—Sediments of the Class A contain about 95% quartz with a little felspar, the rest being made up by biotite, black opaques, garnet, sillimanite and a few grains of monazite, pyroxenes and amphiboles. Biotite content decreases in proportion with increase in distance from Kalingapatam. Garnet, black opaques, sillimanite and white mica in finer fractions are found in varying proportions in all the other sediments. The total heavy mineral content constitutes 10-15% of total sand fraction, the maximum concentration being found in samples from the two isolated sandy patches.

Carbonate Content.—Percentage loss in weight due to digestion of the sediment in 1 : 1 dilute hydrochloric acid is taken to be a measure of carbonate content, which is largely in the form of shell fragments.[3] Sediments of Class A contain only 3% carbonate and these appear to be unfavourable for the thriving of organic life; those of Class B contain 25-36% carbonate; those of Class D contain less than 10% carbonate. Sediments of Class C contain more than 60% carbonate in the form of shells and concretions.

In the light of these observations, the following conclusions are warranted: (1) The silty sands containing significant amounts of biotite are perhaps a part of sediment load discharged by Vamsadhara and Langulya, the only major rivers in the area under investigation. (2) Based on grain size distribution and carbonate percentage, the sediments of the shelf environment can be grouped into: (*a*) Silty sands, between 5-20 fathoms; (*b*) Medium-grained sands with considerable amount of shells, between 20-40 fathoms; (*c*) Shell zone, between 40-60 fathoms; and (*d*) Clay zone, beyond 60 fathoms. (3) Further studies are required to explain the anomalous occurrence of the two coarse-sandy patches.

The investigations were sponsored by the Council of Scientific and Industrial Research.

Dept. of Geology, Andhra University, Waltair, *November* 9, 1955.

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* These numbers refer to the location of the samples.

PEROXIDE OF TITANIUM

THOUGH peroxide of titanium has been known since Weller first prepared in 1882, a controversy exists regarding its composition. Weller,[1] Classen,[2] Levy[3] and Schwarz and Sexauer[4] have shown that the peroxide has the molar ratio of TiO_2 : O (active) as 1 : 1 corresponding to the formula TiO_3, but the work of Billy[5] and Billy and San Galli[6] gives the composition as Ti_2O_5. While attempting to prepare a sample of pure titanium peroxide, it was found that both TiO_3 and Ti_2O_5 could be obtained, the latter being formed on keeping the former for some days. In view of the controversy about the composition of the peroxide, the present investigation was carried out.

Hydrated peroxide of titanium was prepared by addition of 10% ammonia to an aqueous

mixture of purified titanium tetrachloride and hydrogen peroxide ($TiO_2 : H_2O_2 = 1 : 1{\cdot}2$). Addition of excess of ammonia was avoided. The light yellow precipitate, thus obtained, was washed several times with distilled water till free from chloride. The slurry was then analysed for titanium dioxide by ignition. The active oxygen was determined in another aliquot by treating the slurry with acidified potassium iodide and estimating the iodine liberated. The results of analysis showed that the pertitanic acid thus prepared had the composition $TiO_3.xH_2O$ with only traces of TiO_2 (2%) as impurity.

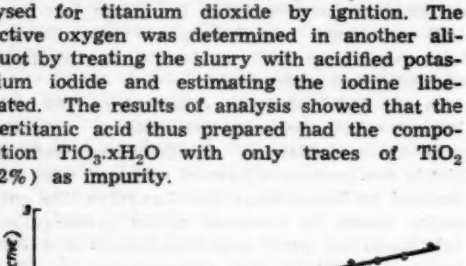
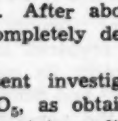


FIG. 1

The keeping quality of the wet peroxide was studied by periodically analysing the slurry. The results are graphically represented in Fig. 1. From the figure, it is seen that the ratio of $TiO_2 : O$ (active) is approximately 1 : 1 in the fresh precipitate corresponding to the composition TiO_3. It is further seen that the pertitanic acid $TiO_3.xH_2O$ goes on losing active oxygen on keeping and after 8 days the composition corresponds to the formula Ti_2O_5. It is interesting to note that the loss of oxygen does not stop with the formation of Ti_2O_5 but continues further. After about 3 months, the pertitanic acid completely decomposed to titanium dioxide.

Thus, the present investigation shows that the peroxide Ti_2O_5, as obtained by Billy and San Galli,[6] is an intermediate decomposition product of TiO_3. Reaction of freshly prepared titanium peroxide with oxalic acid has shown that the former has only two replaceable hydroxyl groups, indicating the following ring structure for the peroxide (pertitanic acid).



This view is in agreement with the structure of peroxy compounds of thorium and zirconium.[7]

The authors wish to thank Prof. K. R. Krishnaswami and Dr. M. R. A. Rao for their keen interest in this investigation.

Dept. of Gen. Chem., Indian Inst. of Science, Bangalore-3, *November* 11, 1955.

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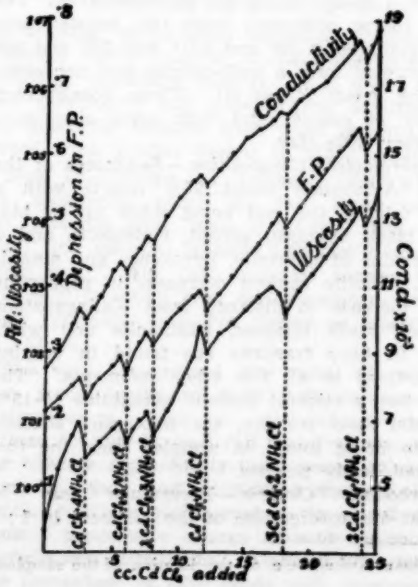
FORMATION OF COMPLEX COMPOUNDS BETWEEN CADMIUM CHLORIDE AND AMMONIUM CHLORIDE

G. C. WITTSTEIN[1] AND K. VON HAUER[2] found that cadmium oxide, hydroxide, or carbonate dissolved in a solution of ammonium chloride with evolution of ammonia, and on evaporation, the solution furnished crystals with very variable proportions of ammonium and cadmium chlorides. Following this observation, efforts were made by various workers to elucidate the composition of the compounds formed. But no systematic study has yet been made.



So it was thought desirable to take up the work.

A.R. grade cadmium chloride and ammonium chloride were dissolved to form M/4 solutions. A series of mixed solutions were then carefully prepared, in which the concentration of one of the constituents was kept constant while the other varied systematically following the method of Nayar and Pande.[3] Each of these solutions was then subjected to careful study by conductivity, density and viscosity, and freezing point measurements. The results are shown graphically. From the graph it is clear that by all the methods six definite breaks are observed at the points corresponding to the formation of the compounds $CdCl_2$. $4\,NH_4Cl$, $CdCl_2$. $2\,NH_4Cl$, $2\,CdCl_2$. $3\,NH_4Cl$, $CdCl_2$. NH_4Cl, $3\,CdCl_2$. $2\,NH_4Cl$ and $2\,CdCl_2$. NH_4Cl. Further work with respect to the formation of complexes between cadmium halides and the corresponding alkali halides is in progress.

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ROLE OF CARBONIC ANHYDRASE IN THE FEMALE GENITAL DUCT OF THE APPLE SNAIL

THE possible role of carbonic anhydrase in the deposition of carbonate in shell was first suggested by Meldrum and Roughton.[1] Common[2] studied this enzyme in the oviduct of hen and concluded that the activity of this enzyme is higher in the uterine epithelium than in the remaining oviductal tissue, and that it might play a part in the secretion of the egg-shell. More recently Freeman and Wilbur[3] and Wilbur and Jodrey[4] studied the carbonic anhydrase activity in the mantle tissue of the molluscs and suggested the possibility of the importance of this enzyme in shell-formation. The present note deals with the study of the distribution of carbonic anhydrase in the female genital duct of the apple snail *Pila virens* (Lamarck) with special reference to the formation of the egg-shell.

For the estimation of carbonic anhydrase the colorimetric method of Brinkman[5] was adopted, which consists in measuring the time taken for a given amount of the enzyme to produce a measured shift in the pH under standard conditions and in the presence of a suitable excess of sodium carbonate. Calcium in the tissue was estimated after ashing the tissue by the oxalate method described by Hawk *et al.*,[6] and the alkaline phosphatase activity of the tissue was estimated by the method of Kind and Mary.[7] In every experiment rigorous controls of boiled extracts were used.

The uterine and vaginal tissues were tested for carbonic anhydrase activity. It was observed that in the vaginal tissue of the female genital duct there is a high carbonic anhydrase activity which reaches the maximum about the time of oviposition. During the period of hibernation there is a very feeble carbonic anhydrase activity. In the uterine tissue the carbonic anhydrase activity is very weak. An examination of the male genital duct has shown a complete absence of this enzyme.

A study of the distribution of calcium in the soft parts of *Pila*[8] has shown that the vaginal tissue contains a large amount of calcium. It has also been observed[9] that there is a sudden rise of calcium and alkaline phosphatase in the vaginal tissue about the time when the animal burrows just before oviposition, and that the egg-shell which consists of about 92% of calcium carbonate is formed entirely in the vaginal region. Table I shows the relation between the distribution of calcium, alkaline phosphatase and carbonic anhydrase in the vagina in the breeding season at different stages.

TABLE I

State of animal	Calcium in mg. per animal	Phosphatase activity*	Carbonic anhydrase activity†
Breeding season ..	108	12·4	2·9
Just before oviposition ..	190	20·2	8·1
After oviposition ..	78	10·2	1·8

* Phosphatase activity is expressed as mg. of phosphorus liberated by a gram weight of the tissue during 2 hours of incubation.

† Carbonic anyhydrase activity is expressed as the ratio of the time of reaction in the heated and unheated extracts.

Thus the great increase in the carbonic anhydrase activity in the vaginal tissue before oviposition finds a parallel in the calcium content of the tissue during the same period. This is strongly suggestive of the possible role of carbonic anhydrase in the formation of the egg-shell of *Pila*.

My thanks are due to Professor R. V. Seshaiya for guidance, and to the Government of India for the award of a senior research scholarship.

Dept. of Zoology, (Miss) V. R. Meenakshi.
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September 1, 1955.

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THE FOOD OF HORSE-MACKEREL *CARANX*

The Horse-Mackerel known as *Parai* in Tamil ranks high among the food fishes in and outside Madras City, and constitutes an important fishery. Chacko[1] has studied the feeding habits of *Caranx hippos* and *Caranx sansun* and found that they feed mainly on teleostean food such as *Leiognathus* sp. and *Stolephorous* sp. Much work has to be done regarding the food of Horse-Mackerels. One hundred and twenty-eight specimens of *Caranx djedaba* were examined from September 1953 to May 1955. This species enters Madras waters about September of each year and migrates elsewhere in May. The data collected show that this fish uses the Madras area as feeding ground and breeds elsewhere.

Except 16 fishes, all had food in the stomach. It is significant to note that these fishes feed less during the immature stages than when they are mature. Table I, based on 128 fishes, illustrates this fact.

Table I

Showing the condition of feed and the length of the fishes examined during the mature and immature stages

Condition of feed \ Length of fishes	10–14 cm.		15–20 cm.		21–25 cm.	
	(*a*)	(*b*)	(*a*)	(*b*)	(*a*)	(*b*)
Empty ..	2	3	3	6	..	2
Little ..	1	4	2	7	..	4
¼ ..	..	7	1	8	1	3
½ ..	9	2	4	2	..	5
¾ ..	7	1	8	2	7	..
Full ..	8	2	10	..	4	3

(*a*) Mature; (*b*) Immature.

The stomach contents were analysed and measurued and the data obtained are given in Table II.

From Table II it will be clear that this fish is carnivorous and that crustacea form the main item of food. Since *Squilla* sp., *Acetes* sp., *Penœus indicus*, cumacea, megalopa, zœa stages of crab and mysis form the chief constituents it may be inferred that this fish is actively predacious and feeds in midwater zones. Of the Entomostraca, only the copepods *Euterpina* sp. and *Acartia* sp. were identified. Apart from this there were also unidentifiable appendages and other remains of crustacea. The teleosteans were observed to form a minor part of the diet when compared with the quantity of crustacea that the fish had consumed. Fish eggs, scales, pectoral girdle, parts of anal fin were also found in the stomach. Species of Clupeidæ and Engraulidæ were the most frequent teleostei on which the fish feeds. Only rarely polychætes occurred in the stomach and it was in the month of October, December and April. Since the polychætes are digested very easily and only setæ are left, no specific identification could be made. Whenever polychætes

Table II

Showing the average volume of food and also the percentage average of the various food items of Caranx djedaba

Particulars	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Vol. of stomach content in c.c. ..	0·5	0·3	0·4	0·3	0·4	0·5	0·5	0·5	0·3
Crustacean item ..	69·5	92·0	82·6	80·0	77·4	88·9	73·3	71·1	79·5
Teleostean item ..	25·5	4·1	15·7	15·4	17·5	10·1	12·8	21·5	15·3
Polychætes ..	..	2·6	..	1·3	..	..	..	3·3	..
Sand particles ..	..	1·3	..	1·2	..	..	..	1·9	..
Other food items ..	5·0	..	1·7	2·1	5·1	..	13·9	2·2	5·2

were present small quantities of sand particles were also found in the stomach. It is probable that these are derived from the polychætes. The amount of vegetable stuff the fish fed on was very little. Only very small amounts of algæ and diatoms were found, and these were usually in an advanced state of digestion—only Coscinodiscus could be identified.

Since crustacea form 79·2% of its diet, it is highly probable that this species does not destroy the young ones of *Leiognathus* and *Stolephorous* to the extent that Chacko[1] has recorded. The teleostean food item forms only 15·3% of the total volume of the stomach contents. Of this, Clupeids form a considerable proportion. No Carangids were identified. Therefore it may be concluded that the difference in the data presented by Chacko and the present author may be due to the different localities from which the fish were caught.

Thanks are due to Prof. C. P. Gnanamuthu for guidance and encouragement.

Zoological Res. Lab., Chepauk, Madras-5, *September* 21, 1955.

M. D. K. KUTHALINGAM.

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FEEDING HABITS OF FRESH-WATER FISHES OF UTTAR PRADESH

WHILE studying the food of the adult fishes of Uttar Pradesh during 1953-55 it was observed that fishes have definite affinities to particular water-levels according to their specific foods, and the fauna and flora present at these levels. Such associations were also observed earlier by Mookerjee, Sen Gupta and Roy Chowdhury[1] in Bengal, and Misra[2] in three species of carps in U.P., but to our knowledge this is the first attempt to survey the food affinities of a majority of food fishes of U.P.

Weekly fish hauls were made in local tanks and ponds during 1953-55. Fishes belonging to twenty-seven species and of different size-groups were obtained. These were brought to the laboratory where they were identified, measured and weighed. The date, time and locality of the hauls were noted. The abdomen was then opened and the fishes fixed in 8-10% formalin for later investigations. The stomach and the intestine were carefully removed and split open and the contents washed with water into a petri-dish. The material was next examined and counted under the low and high powers of the microscope on a counting slide. The percentage composition of the gut contents was estimated by the latest method followed by Hynes.[3]

Of the fishes examined, the food of the following eight species, *viz.*, *Gadusia chapra* (Ham.), *Ailia coila* (Ham.), *Catla catla* (Ham.), *Ambassis nama* (Ham.), *Ambassis ranga* (Ham.), *Glossogobius giuris* (Ham.), *Callichrous pabda* Ham., and *Oxygaster bacaila* Ham., consisted of desmids (*Closterium*, *Cosmarium*), diatoms (*Cyclotella*, *Nitzchia*, *Synedra*), plankton algæ (*Volvox*, *Gonium*, *Phacus*, *Eudorina*, *Pandorina*, *Nostoc*, *Oscillitoria*, *Gleotrichia*, *Microcystis*, *Spirogyra* and *Ulothrix*), plankton rotifers (*Rotifer*, *Rattulus*), plankton crustaceans and their larvæ (*Bosmina*, *Daphnia*, *Ceriodaphnia* and *Cyclops*), as well as pelagic insects and their larvæ. Job[4] concluded that *Therapon jerbua* was a surface-feeder due to the presence of insect larvæ and adult mosquitoes in its stomach contents. Similarly Mookerjee *et al.*,[1] held that fishes living at the surface feed on crustacea and algæ, whereas the fishes which feed on rotten plants, sand and mud are bottom-feeders. We have however recovered many more types of surface or planktonic food organisms from the gut contents of the fishes listed above and conclude therefore that they are surface feeders. These fishes include both omnivorous and carnivorous forms.

The following nine species of food fishes, *viz.*, *Labeo rohita* (Ham.), *Labeo bata* (Ham.), *Amblypharyngodon mola* (Ham.), *Mystus seenghala* (Sykes), *Mystus vittatus* (Bloch.), *Mystus cavasius* (Ham.), *Mastacembelus armatus* (Lacep.), *Wallago attu* (Bl. & Schn.), and *Xenentodon cancilla* (Ham.), had a food-content of algæ, aquatic plants, adult crustaceans (shrimps), insects and their larvæ (water-bugs, mayflies, damselflies), fish (carp fingerlings and cyprinids), fish scales and sometimes sand and mud particles. These fishes are neither purely surface-feeders nor purely bottom-feeders, since the food organisms recovered from their gut-contents are distributed more in the middle layer of the waters than in the surface or bottom layers. These fishes may occasionally come up near the surface or go down to the bottom in search of their food, but in the main they are mid-feeders. We therefore conclude that the above-mentioned species are mid-feeders since they feed essentially on sub-surface food organisms. They contain both herbivorous and carnivorous forms.

The food of the remaining ten species, *viz.*, *Cirrhina mrigala* (Ham.), *Cirrhina reba* (Ham.), *Labeo calbasu* (Ham.), *Puntius sarana* (Ham.), *Puntius sophore* (C. & V.), *Rohtee cotio* (Ham.), *Clarias batrachus* (Linn.), *Heteropneustes fossilis* (Bloch.), *Ophicephalus striatus*, (Bloch.) and *Rita rita* (Ham.), consisted of decomposed aquatic plants (*Vallisnaria, Hydrilla, Salvinia*), bryozoans (*Plumutella, Pectinatella*) and their statoblasts, molluscs (*Vivipara bengalensis, Lamellidens* sp.), fish (carp fingerlings and cyprinids), fish scales and *large quantities of sand and mud*. Bottom crustaceans were frequently present in the gut contents but not the pelagic cladocera and copepods. Bapat and Bal[5] included *Herengula punctata* and *Nematolosa nasus* among the bottom-feeders as mud and sand were found in large quantities in their stomachs. But, besides large amounts of sand and mud, we have also recovered many types of bottom-dwelling forms, *viz.*, bryozoans, molluscs, etc., in the gut contents of the fishes listed above, as also decomposed aquatic vegetation. From these observations we conclude that these fishes are bottom-feeders and they contain herbivorous, omnivorous and carnivorous forms.

It is interesting to note that the surface-feeders are both omnivorous and carnivorous; the mid-feeders, herbivorous and carnivorous; and the bottom-feeders, herbivorous, omnivorous and carnivorous. Hence competition for food is greatest in the bottom layer of the waters, while there is almost equal competition in the surface and the middle layers.

The food in these three layers of water is not uniform throughout the year, but varies in the different seasons. We have found that the herbivorous and the carnivorous fishes show definite peak periods in feeding, while the omnivorous ones show little variation throughout the year. This is probably so because phytoplankton and zooplankton have an inverse ratio[6] in their abundance during the year, which signifies that if one kind of food is less the other is present in larger amounts for the fish to have normal feeding.

Work is still in progress and a comprehensive account of the food and feeding in U.P. fishes will be published subsequently.

The authors wish to acknowledge their gratitude to the Scientific Research Committee, U.P., but for whose help the present studies would have been impossible.

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SILVANUS IYERI VAR. *MYSORENSIS*, NEW VARIETY

Imms and Chatterjee[4] mention that *Silvanus iyeri* was first discovered by V. S. Iyer in 1910, which naturally precludes its mention in earlier publications like those of Stebbing.[5] They found it "widely distributed". Its colour is yellow brown and has been illustrated accordingly in their Fig. 30. They state that "in its larval stage it is a common enemy of the lac insect", without precisely mentioning whether it is predaceous on living lac insects,—a fact which could be easily established on dissecting out the digestive canal which would be full of the bright-red lac-dye. The bibliography on lac published by Chatterjee,[1] does not give references to the class of beetle enemies of lac, much less to *S. iyeri* by name. In a publication issuing from the same Institute, Glover[3] only adds to our previous information by saying that, of the beetles that were commonly bred (from lac) *S. iyeri* could be mentioned as first. He makes no comments upon the previous record by Imms and Chatterjee[4] that *S. iyeri* "is less abundant than *Bergiinus maindroni*". My own findings support Imms and Chatterjee, for the latter species can relatively feed on dead insects, thus accounting for its larger occurrence.

From lac of *Lakshadia mysorensis*, I was able to breed a much darker insect, which differs from the typical *S. iyeri* only in its colour which, instead, was dark-brown, comparable with that of *Silvanus surinamensis* L. (Figs. 1-4).

Ferwerda[2] has published an excellent memoir on the genetics of *Tenebrio molitor*, the meal worm. He has shown that the varieties differing in colour represent genetically different varieties and colour is not a function of their food. I have reared the typical *S. iyeri* on *L. mysorensis* and confirmed that it maintains its colour, which is yellowish brown like that of polished wood, even on this lac insect. The reverse experiment, of feeding the dark insect, *S. iyeri* var. *mysorensis*, on lac other than that of

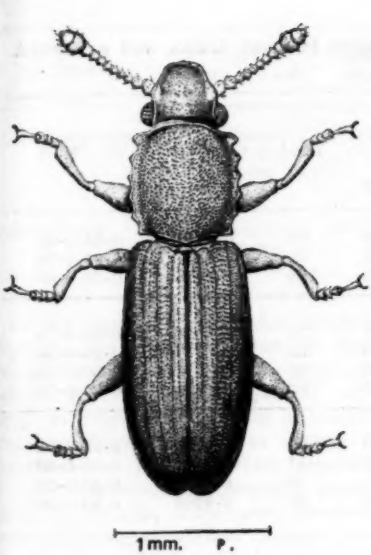

FIG. 1.

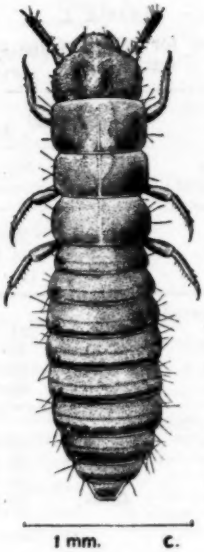

FIG. 2.

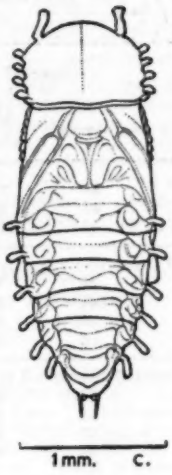

FIG. 3.

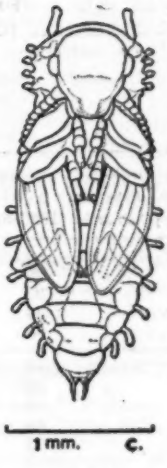

FIG. 4.

Fig. 1. *Silvanus iyeri* var. *mysorensis*—adult. Fig. 2. Full-grown larva of *S. iyeri* var. *mysorensis*. Fig. 3. Pupa of *S. iyeri* var. *mysorensis*—dorsal view. Fig. 4. Ventral view.

Mysore could not be undertaken as it required feeding it on other species which were not available in quantity. The presence of a dark brown variety, peculiar to Mysore, requires the creation of a new name for it and has been designated accordingly.

Biochemistry Division, S. MAHDIHASSAN.
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INHERITANCE OF FILAMENT COLOUR IN TOBACCO

FILAMENT colour in tobacco is normally green. But there are many types which have pale or light yellow and white filament. In rare cases pink filaments are also found. In our collection there are types with fully pink filaments and those in which filament has a pink wash confined to the tip only. Among the fully pink types the intensity of the colour varies from faint to deep pink.

Kelaney[1] dealing with a fully pink filament type reported that the pink colour is controlled by two complementary genes giving a ratio of 9 pink : 7 green. In a cross between two flue-cured varieties, Kadam and Murty[2] found that an inhibitor, controlling the filament tip colour, was operating giving a ratio of 13 colourless to 3 coloured. In their cases, the pink wash was confined to the tip of the filament just below the attachment to another. We present now a third case where the filament tip colour is controlled by two complementary genes.

Lanka, an indigenous petiolate type, was crossed with a Turkish petiolate variety in 1950-51 with a view to increase the leaf-number of the *Lanka* tobacco. The *Lanka* variety has pale filament while the other type has a pink wash at the tip of the filament. The F_1 was petiolate and had a pink wash similar to the Turkish parent. The F_1 was grown in 1951-52 and the F_2, the next season. For confirming the F_2 behaviour, nineteen plants were selected at random for F_3 generation. In 1953-54 back-cross of the F_1 to *Lanka* and the F_2 generation were also grown again along with the 19 F_3 families. The segregations of the various generations are presented in Table I.

TABLE I

Segregation in F_2, F_3 and back-cross for filament tip colour between Lanka and a Turkish variety

	Observed		Expected		Total	χ^2	P
	Coloured	Not coloured	Coloured	Not coloured			
F_2 (1952–53) (9 : 7)	35	29	36·00	28·00	64	0·0635	0·80–0·90
F_2 (1953–54) 9 : 7)	41	37	43·88	34·12	78	0·4306	0·50–0·70
F_1 × *Lanka* (1953–54) (1 : 3)	48	117	41·25	123·75	165	0·1473	0·70–0·80
F_3 Families segregating 9 Coloured : 7 not Coloured							
29	46	32	43·88	34·12	78	0·2352	0·50–0·70
35	47	38	47·81	37·19	85	0·0316	0·80–0·90
38	56	40	54·00	42·00	96	0·1703	0·50–0·70
65	54	38	51·75	40·25	92	0·2236	0·50–0·70
F_3 Families segregating for 3 Coloured : 1 not Coloured							
23	67	22	66·75	22·25	89	0·0037	0·95–0·98
56	62	19	60·75	20·25	81	0·1029	0·70–0·80
58	62	17	59·25	19·75	79	0·5105	0·30–0·50
73	50	16	49·50	16·50	66	0·0203	0·80–0·90

TABLE II

	Pure for Coloured	9 Coloured : 7 Colourless	3 Coloured : 1 Colourless	Pure for Colourless	Total	χ^2	P
Observed ..	3	4	4	8	19		
Calculated (1 : 4 : 4 : 7)	1·1875	4·7500	4·7500	8·3125		3·0149	0·30–0·50

It will be seen that the F_2, F_3 and back-cross numbers agree well within the expected segregations.

Out of the 19 F_3 families, 8 bred pure for colourless condition, 4 families segregated 9 coloured : 7 not-coloured and another four gave a ratio of 3 coloured : 1 not-coloured and 3 families bred pure for coloured condition. The frequencies of the different categories of families agree well with the expectation as is seen from Table II.

The complementary genes for the pink colour of the filament are designated Fp_a and Fp_b.

B. S. KADAM.*
B. RADHAKRISHNAMURTHY.
Central Tobacco Res. Inst.,
Rajahmundry, *September* 30, 1955.

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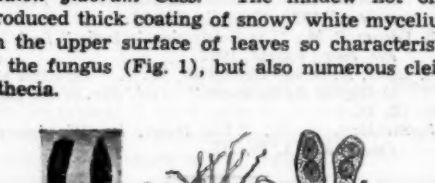
* Now Director of Agriculture, Rajkot, Saurashtra.

A NEW SPECIES OF *ERYSIPHE*

AN ectophytic powdery mildew was collected by the writer in September 1954, in the vicinity of Poona on a hitherto unreported host, *Goniocaulon glabrum* Cass. The mildew not only produced thick coating of snowy white mycelium on the upper surface of leaves so characteristic of the fungus (Fig. 1), but also numerous cleistothecia.



FIGS. 1–6.—Fig. 1. Effect on leaves. Fig. 2. Section showing haustoria, × 202. Fig. 3. Conidia, × 240. Fig. 4. Cleistothecium, × 95. Fig. 5. Asci, × 240. Fig. 6. Ascospores, × 240.

TABLE I

Fungus	Conidia Size and nature	Cleistothecia diameter	Appendages	Asci No. and dimensions	Ascospores No. and dimensions	Authority
E. cichoracearum	Catenulate 24-43·2× 14·4-26·4 μ	84-168 μ	Long 13-35	5-15 43·2-74·4× 25·2-45·6 μ	Two or three variable 16·8-31·2× 12·0-19·2 μ	Homma[2]
Poona Mildew	Catenulate 22-30·6× 13·6-17 μ	89·7-124·6 μ	Short numerous	3-5 34-59·5× 20·4-29 μ	Two constant 10·2-17·0 μ	..

Of the three sections under which the genus *Erysiphe* has been separated by Homma[2] the Poona fungus has similarities with *E. cichoracearum* DC. A close comparison of the two fungi as presented in Table I, however, shows that the Poona fungus has several distinctive morphological features which separate it from *E. cichoracearum*. The generally smaller dimensions of conidia, ascospores, cleistothecia and their appendages, constant number (generally 4) of asci to a cleistothecium and the regularly two-spored asci clearly distinguish the Poona fungus from the *cichoracearum* type.

The Poona fungus is, therefore, described as a new species.

Erycibe poonœnsis KAMAT, SPEC. NOV.

Mycelium ectophyticum, densum, persistens, niveo-album in mass, ornatum haustoriis globularibus vel ovalibus in cellulis epidermalibus. Conidiophori simplices, breves et erecti; conidia ovata vel doliiformia, hyalina, 22·0-30·6 μ × 13·6-17·0 μ, catenata, unaquaque catena constante ex 3-5 conidiis. Cleistothecia brunnea vel fusce brunnea, globularia, 89·7-124·6 μ gregaria appendicibus myceloideis, septatis, pallide brunneis, longitudinis 39·0-136 μ. Asci ut plurimum 4, nonnumquam 3-5, ellipsodcæ, brevi pedicellati 34-59·5 μ × 20·4-29·0 μ regulariter dispositi. Ascosporæ globularibus, pallide brunneæ, 10·2-17·0 μ simper binæ in singulis ascis.

Typus lectus in partibus æreis *Goniocauli glabri* Cass. in urbe Poona, in India, a P. P. Chiddarwar.

The author is grateful to Prof. M. N. Kamat for guidance and to Mr. E. W. Mason of the Kew Mycological Institute, and Rev. Father H. Santapau for helpful suggestions and Latin diagnosis respectively.

The type specimens have been deposited at the Herbaria of the Commonwealth Mycological Institute, Kew, England, and Indian Agricultural Research Institute, New Delhi, India.

M.A.C.S. Laboratory, Law College Buildings, Poona, *July* 26, 1955. P. P. CHIDDARWAR.

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EFFECTS OF LONG PHOTOPERIOD ON FOUR EARLY-WINTER VARIETIES OF RICE

PURE grains of four early-winter varieties of rice, two varieties T. 1145 ("Usha" of Puri District) and T. 36 (a selection from No. 1 Cuttack) grown in Orissa and the other two T. 23 ("Kala Sukhadas" of Banda District) and T. 17 ("Bansi" of Allahabad District) grown in Uttar Pradesh were sown in seed-bed pots on June 18, 1949. The 24-hour long photoperiod (obtained by supplementing the natural day-length with artificial illumination from a 500-watt gas-filled Osram bulb hung at a height of 5′ from evening to morning) was given to 7-day-old seedlings for 3 weeks in one set and for 6 weeks in another. A third set was all along kept as control which received the normal day-length prevalent in the growing season. The seedlings in all the sets were transplanted to bigger pots at the age of 49 days and were kept till harvest in the open pot-culture enclosure. Each set had 6 pots with 4 plants per pot. The experimental results are presented in Table I.

A study of Table I leads to the following salient points: Continuous illumination for 3 weeks in the seed-bed had no effect on the onset of flowering, but treatment for 6 weeks on the average had slightly delayed the ear emergence. All the varieties did not behave

TABLE I

		T.1145	T. 23	T. 36	T. 17	Mean
Days from sowing to ear emergence	A	119·55	119·10	119·50	115·90	118·51
	B	118·90	120·25	119·50	115·80	118·61
	C	120·15	123·90	120·65	116·10	120·20
Grain yield per plant in grams	A	7·62	5·60	7·13	8·02	7·09
	B	10·13	5·72	9·52	10·15	8·88
	C	6·65	5·00	8·27	7·58	6·87
Number of panicles per plant	A	4·00	2·05	2·20	3·30	2·88
	B	4·70	2·25	2·70	3·50	3·28
	C	4·60	2·40	2·45	3·40	3·21
Length of panicle in cm.	A	18·40	27·02	23·26	21·32	22·50
	B	19·00	25·36	25·02	22·28	22·91
	C	18·00	22·94	24·04	21·96	21·73
Number of grains per panicle	A	90·30	112·16	98·16	96·92	99·38
	B	101·28	114·72	106·80	111·68	108·62
	C	71·52	100·16	107·84	92·18	92·92
Number of spikelets per panicle	A	107·90	138·22	123·32	115·80	121·31
	B	120·62	134·18	140·06	129·60	131·11
	C	87·88	127·92	130·46	111·88	114·53
Percentage of grains set per panicle	A	83·80	80·94	79·58	83·44	81·94
	B	84·26	85·64	76·26	86·64	83·20
	C	81·02	78·16	82·18	82·24	80·90
Weight of 1000 grains in grams	A	20·84	23·92	33·00	25·54	25·32
	B	21·32	22·06	33·08	25·58	25·51
	C	20·60	20·96	32·88	24·52	24·74

A—Control; B—Long day for 3 weeks in seed-bed to 1-week-old seedlings; C—Long day for 6 weeks in seed-bed to 1-week-old seedlings.

uniformly. The delay in the ear emergence as a result of long-day treatment for 6 weeks was pronounced only in the variety T. 23 whereas in the other 3 varieties the delay was not statistically significant. A significant higher grain yield was, however, obtained by long-day treatment for 3 weeks in all the varieties, mainly due to the increase in the number of panicles per plant and number of grains per panicle. The setting percentage and one thousand grain-weight were slightly different and did not contribute to the yield difference to any appreciable degree. The treatment for the longer duration of 6 weeks did not show any difference in grain yield from the controls.

The behaviour of these four early-winter varieties to long photoperiods is therefore different from two *aus* and two late-sown *aman* varieties of Bengal where Kar[1] and Sen[5] respectively obtained earliness. Misra[4] with similar long-day treatments as of the present investigation obtained slight earliness in the treatment for 3 weeks and considerable delay in treatment for 6 weeks with T. 3, T. 12 and T. 21, three medium-early varieties of rice of U.P. In other studies with two early varieties, T.N. 32 and T.N. 22 of U.P., Misra[2,3] obtained marked delay in ear emergence.

Thanks are due to Dr. Shri Ranjan, Allahabad, for his guidance and stimulating criticism throughout the work at the University Botanical Laboratories.

Dept. of Botany, GADADHAR MISRA.
Ravenshaw College,
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CHROMOSOME NUMBERS IN THE FAMILY COMBRETACEAE

THE family Combretaceæ is mainly tropical and subtropical in distribution. The members of the family are widely distributed in India. In Bengal, Prain[1] records the presence of twenty species belonging to seven genera.

The literature on the cytology of the family is very meagre. Simmonds[2] has recently reported the somatic number of chromosomes in *Terminalia catappa*, while Sen and Sen[3] have determined the meiotic and somatic number in *Quisqualis indica*.

The present study is confined to the following genera: *Terminalia*, *Combretum* and *Quisqualis*. The materials were obtained from plants growing in the college campus and from the Indian Botanical Garden, Sibpur.

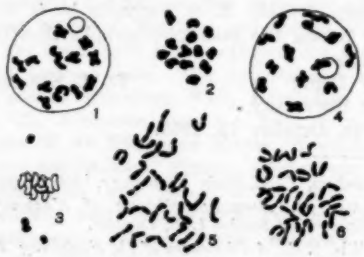
Root-tips, collected from seedlings for the study of somatic chromosomes were fixed in Lewitsky's chromic acid and formalin 1 : 1, and also in platinic chloride (1% aqueous) and formalin (10%) 1 : 1 and 1 : 1·5. The latter gave better results. For the study of meiosis flower buds were fixed in Nawashin's A & B and ·002 M oxyquinoline in the proportion of 1 : 1 : 1.[4]

The results of the investigation as also the previous determinations in the family are given in Table I.

TABLE I

Name of plant	Chromosome Nos.		Determined by
	n	2*n*	
Quisqualis indica	13	26	Sen, S. & Sen, N. K.
,,	13	26	Present author
Terminalia arjuna	13	26	,,
T. bellerica	13	26	,,
T. chebula	13	..	,,
T. catappa	..	24	Simmonds, N. W.
,,	13	..	Present author
Combretum gloriosum	22	..	,,

It will be seen from the above table that the basic number of chromosomes in *Terminalia* and *Quisqualis* appears to be 13. Simmonds, however, records $2n = 24$ for *T. catappa*; whereas the present author has observed the presence of 13 clear bivalents during diakinesis and metaphase I (Figs. 1 and 2) of dividing pollen mother cells. Simmond's work, therefore, requires corroboration before it can be accepted. The occurrence of 22 haploid chromosomes in *Combretum gloriosum* indicates that there may be more than one basic number of chromosomes in this family.



FIGS. 1–6

Figs. 1, 2 and 3 *Terminalia catappa*. Fig. 1. Diakinesis showing 13 clear bivalents; Fig. 2. Metaphase I, plate showing 13 bivalents; Fig. 3. Side view metaphase I, showing early separation and non-disjunction of bivalents; Fig. 4. *Terminalia bellerica*. Diakinesis showing 13 bivalents and inter-bivalent connection. Fig. 5. *Terminalia arjuna*. Somatic metaphase plate showing 26 chromosomes; Fig. 6. *T. bellerica*. Somatic metaphase plate showing 26 chromosomes. Figs. 1 to 4, ×1,250, Figs. 5 and 6, × 800.

Meiotic irregularities have been observed in *T. catappa* and *T. bellerica*, which will be dealt with in a separate paper, where a full account of the investigation will be presented.

My thanks are due to Dr. I. Banerji, under whose guidance the investigation is being carried on.

Dept. of Botany, SUBIR SEN.
Calcutta University,
July 2, 1955.

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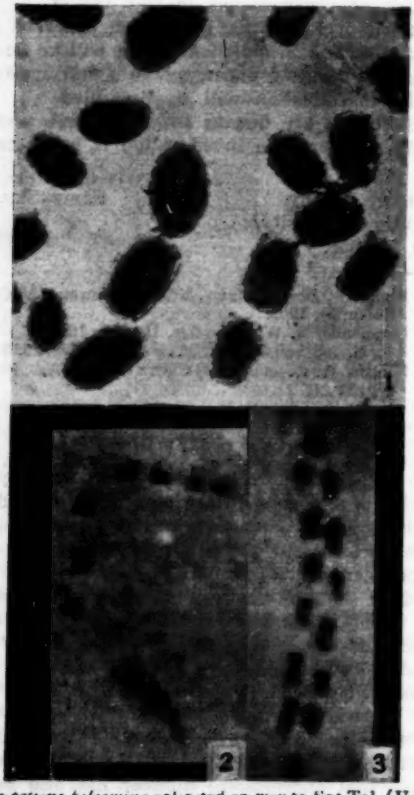
CYTOLOGY OF *IMPATIENS*

THE author noticed in North-West Himalayan species of the genus *Impatiens* that the pollen at shedding contains a big but faintly stainable tube nucleus and a deeply stainable crescent-shaped generative nucleus. At this stage aceto-carmine squash of the pollen grains reveals the generative nucleus in prometaphase from which the chromosomes can be easily counted. Generally the generative nucleus continues to remain in prometaphase even in the pollen of the pressed specimens from which also the chromosome number has been successfully determined by the author.[1] It may be mentioned that chromosome number has also been determined from a plant of *I. roylei* collected in 1900 from Pahalgam (Kashmir). It is not known how far this holds true for the rest of the genus. So far definite results have not been obtained with *I. holstii* Engl. & Warb.

Through the kindness of a number of friends it has been possible to have pressed material from many localities. Some of the Himalayan species have been sampled from almost their entire range. This increased the chances of discovery of any variations in meiosis or in chromosome number of pollen grains. The present observations are summarized below:

I. edgeworthii ($n = 6$) has the lowest chromosome number so far recorded for the genus. Many interesting irregularities have been noted in meiosis of pollen mother cells of *I. balsamina* and *I. scabrida*. *I. thomsoni* ($n = 7$ & 10) occurs in two cytological races. In this connection it is of interest to note that Blatter[2] has illustrated this species with two figures

which are morphologically distinguishable from each other.



Impatiens balsamina collected on way to Sat Tal (U.P.) in August, 1949.

FIG. 1. Haploid and Diploid pollen grains, × 325.

FIGS. 2-3. Generative nuclei in division showing 7 chromosomes in haploid grain (Fig. 2) and 14 chromosomes in diploid grain (Fig. 3). Note a faint tube nucleus on the lower side of Fig. 2, × 2,840.

Data compiled from the cytological work including the present investigation indicates that out of 340 species[3] belonging to this genus, only 23 have been cytologically worked out. One species has 6, ten have 7, four have 8 and eight have 10 chromosomes. Out of these, three species have been reported in more than one cytological race. These are *I. thomsoni* ($n = 7$ & 10), *I. roylei* ($n = 9$ & 10) and *I. parviflora* DC. ($n = 10$, 12 & 13). The over-all series is $n = 6$, 7, 8, 9, 10, 12 & 13. At present it is difficult to draw any conclusions about the basic number or numbers of this genus since it is unknown whether in the evolution of this genus there has taken place a phylogenetic reduction in chromosome number or its increase or both.

Species	Haploid chromosome number	Material*
I. edgeworthii Hook.	6	P.M.C., P.G. & H.S. $n = 5$, 6, 7
I. amphorata Edgew.	7	P.M.C., P.G. & H.S.
I. balfourii Hook.f.	7	P.G. & H.S.
I. balsamina Linn.	7	P.M.C., P.G. & H.S. $n = 7$, 11, 12, 13, 14
I. brachycentra Kar. and Kir.	7	P.G. & H.S.
I. scabrida DC.	7	P.M.C., P.G. & H.S. $n = 6$, 7, 8
I. platypetala Lindl. var. *aurentiaca*	7	H.S. (from Bogor, Indonesia)
I. species	7	do
I. thomsoni Hook.f.	7	P.M.C., P.G. & H.S.
	10	do
I. amplexicaulis Edgew.	10	P.G. & H.S.
I. biflora Walt.	10	H.S. (from Pennsylvania)
I. roylei Walp.	10	P.M.C., P.G. & H.S.
I. sulcata Wall. (*I. gigantea* Edgew)	10	do

* P.M.C.—Pollen mother cells, Fresh or fixed pollen grains. H.S.—Pollen grains from Herbarium sheets.

Furthermore it is not clear whether or not some of the higher numbers have been compounded by polyploidy involving forms with the lower chromosome numbers. A study of the karyotypes is in progress to know if this data can provide any clue for the probable trend.

The author is indebted to Prof. P. N. Mehra for his advice and encouragement, and to Mr. M. B. Raizada and Mr. D. Boomsma for their help. To Mr. R. S. Pathania he is thankful for taking the microphotographs illustrating this paper.

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GALL FORMATION IN THE ROOTS OF *ECLIPTA ALBA* LINN.

THE normal roots in *Eclipta alba* are smooth, cylindrical and white to yellowish brown but the roots infected by the nematode, *Heterodera marioni* remain short and exhibit local swellings or galls. These galls are spherical, spindle-shaped or tapering towards the tip. Round and tiny galls are scattered over the finely-branched rootlets. Sometimes three or four galls

are seated together to cause the root a twisted appearance. The galls measure from 1-6 mm. in diameter and 3-20 mm. in length. They are dotted with yellow or brown spots. In young seedlings the infected roots are associated with some brown viscid fluid at the dotted spots.

The normal root shows distinct epidermis, cortical parenchyma with air-spaces, and a central pentarch stele. In the infected root, the structure is considerably changed, the main changes being enlargement of endodermal cells, xylem vessels and xylem parenchyma even before the parasite enters, and they finally get attached to the vessels. In extreme cases the cavities produced by the nematode occupy the whole of the central stele and very few vascular elements remain. *Lippia nodiflora* retained in the stele a few xylem bundles whereas it was not so in the *Eclipta alba*. Experimentally infection with the nematode could be induced even without wounding the root system of these two hosts.

Thanks are due to Prof. M. Sayeduddin and Drs. M. A. Salam and M. R. Saxena for their valued advice.

Dept. of Botany, (Miss) Q. Siddiqui.
Osmania University,
Hyderabad-Dn., *April* 3, 1955.

CYTOLOGY OF CYATHEACEAE, WOODSIAE AND MARATTIACEAE

A cytological study of five members of Cyatheaceæ, three of Woodsiæ and one of Marattiaceæ has been made from acetocarmine squashes of the mother cells. The investigated species are *Cyathea spinulosa* Wall, *Hemitelia brunoniana* Cl., *Alsophila glauca* j. Sm., *A. oldhami* Bed. and *A. cf. Khasyana* Moore (Cyatheaceæ); *Dicalpe aspidioides* Blume, *Peranema cyatheoides* Don and *Woodsia elongata* Hook. (Woodsiæ), and *Angiopteris evecta* Hoffman (Marattiaceæ). These were collected from Darjeeling Himalayas.

The n chromosome for all the five members of Cyatheaceæ is 69. *Hemitelia brunoniana* has got remarkably small chromosomes which at diakinesis are almost round, while all the three species of *Alsophila* show larger chromosomes with X-, Y-, O- and V-shaped configurations (Fig. 1). The chromosomes of *Cyathea spinulosa* are intermediate in size between the two.

Because of the $n = 69$ in all the five members belonging to the three genera, *Cyathea*, *Hemitelia* and *Alsophila*, the cytological data would tend to support the suggestion of Holttum[1] and Copeland[2] in favour of submergence of the three genera into the single genus *Cyathea*. But the character of indusium (complete and inferior in *Cyathea*, incomplete and scale-like in *Hemitelia* and complete absence in *Alsophila*) cannot be easily brushed aside as a feature of little importance.

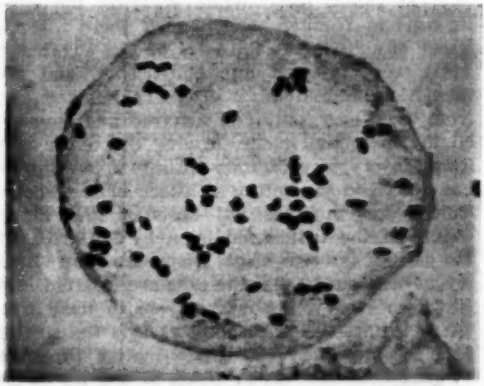

Fig. 1. *Alsophila oldhami*, $n = 69$.

All the three representatives of Woodsiæ, namely, *Dicalpe aspidioides*, *Peranema cyatheoides* and *Woodsia elongata* show 41 bivalents at diakinesis except *W. elongata* where in addition to $n = 41$, three mother cells with $n = 82$ have also been observed. This shows the monoploid number 41 in the alliance which suitably fits in with the 41 series characteristic of Dryopteroid ferns.[3] It may be concluded that Woodsiæ with $n = 41$ is correctly related to Dryopteroid ferns and its affinities with Cyatheaceæ having $n = 69$ appear to be obscure.

In *Angiopteris evecta* (Marattiaceæ) n is 40 while Manton and Sledge (*loc. cit.*) have recorded a tetraploid form of *A. evecta* from Ceylon with $n = 80$.

The meiosis is normal in all the members investigated. A fuller report appears elsewhere.

Dept. of Botany, P. N. Mehra.
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EGG-LAYING AND FEEDING BEHAVIOUR OF SUGARCANE HISPA *ASAMANGULIA CUSPIDATA* MAULIK

HISPID beetles (which are leaf-miners in their young stages) have been recorded as common pests on economic crops such as sugarcane. rice, *Sorghum*, etc. While studying the egg-laying and feeding behaviour of these insects, Issac[1] observed that the eggs of the sugarcane hispa were inserted into leaf-tissues, and although a large number of grubs hatched out from these eggs, only one survived and devoured the mesophyll alone, leaving the upper and lower layers of epidermis entirely free. Gupta[2] has described the nature of attack of the sugarcane hispa but has not specified the exact nature of the tissues fed upon by the grub. In the case of the rice hispa, *Hispa armigera* Oliv., Ayyar[3] has stated that the eggs are inserted into the tissues of young leaves close to their tips. On hatching, the grub burrows into the tissues and feeding upon the green matter produces the characteristic blister-patch at the tip of an infested leaf. Recently De and Konar,[4] while describing the nature of attack of the *Jowar* hispid, *Dactylispa albopilosa* Gestro, have mentioned that it feeds voraciously on the tissues between the two epidermal layers of the lamina and finally pupates within, as in the case of all the other species mentioned above. The present note seeks to adduce evidence to show where exactly this pest lays its eggs and what tissues it feeds upon.

From an examination of the transverse section of a sugarcane leaf wherein the hispa has laid eggs, it is evident that the tissues inside the leaf are intact, showing a rupture more or less in the middle in the longitudinal plane only. The insects inserts its ovipositor to rupture the lower epidermis and makes a longitudinal slit in the lamina wherein eggs are laid in clusters which may contain as many as 11 eggs. The portion naturally becomes raised. On hatching, only one grub apparently survives and feeds on the softer tissues consisting of mesophyll, the chlorophyll-bearing ring of cells outside the larger vascular sheaths and the vascular bundles not protected by sclerenchymatous cells. It mostly confines its activity along the lower epidermis, thus, leaving the tissues of the larger vascular bundles intact (Fig. 1), the sheaths of which are hard and evidently not nutritious like the soft parenchymatous chlorophyll-containing cells. The hard upper layers appear thus to give the insect protection from unfavourable conditions such as strong insolation and the resultant heat, as also from its enemies.

FIG. 1. T.S. of sugarcane lamina showing a portion of vascular bundle under higher magnification, × 100.

The authors are grateful to Sri. K. L. Khanna, for affording facilities and encouragement, and to Sri. S. L. Sharma for going through the manuscript.

Central Sugarcane Research Station, Pusa (Bihar), *September* 6, 1955.

V. G. PRASAD.
S. B. TRIAR.

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EINSTEINIUM AND FERMIUM

TWO new words, *einsteinium* and *fermium*, were used for elements No. 99 and 100 by A. Ghiorso (U.S.) in a discussion of the chemistry of heavy elements at the recent International Conference on the Peaceful Uses of Atomic Energy. Both elements were first discovered in debris from the October 1952 H-bomb explosion by G. Seaborg. Both einsteinium, symbol E, and fermium, symbol Fm, have since been formed in the University of California cyclotron and in nuclear reactors at Argonne National Laboratory and Los Alamos, N.M. All discovered elements through No. 101, mendelevium, have now been named.

REVIEWS

Optical Glassworking. By T. Twyman. (Hilger and Watts Publication), 1955. Pp. viii + 275. Price 24 *sh.*

The book is an abridged edition of the author's "Prism and Lens Making" published for technicians actually engaged in the manufacture of optical components. Written, as it is, by a world authority on this subject, its value as a guide for workers in this field is immense. Being more concise than the original, it forms a convenient book of reference on the optical work bench.

Optical technology is a living subject advancing rapidly into engineering proportions. Techniques not only in attaining higher precision, but also in large-scale production, are making rapid strides in the manufacture of optical components. For a person engaged in this line of work, periodical publications of this type, will keep him abreast of the latest developments in technique, without his being obliged to constantly refer to journals, which have not only multiplied in number, but also in the volume of new material published in them. The latter are of interest only to research workers and directors of optical operations. Twyman has done well in omitting such portions from the abridged book. Topics like theories of grinding and polishing, manufacturing processes for abrasives, process layouts in optical workshops, prescription of spectacle lenses, general theories of microscope objectives, latest developments on production of aspherical surfaces, recent advances in microscopy like U-V microscope, phase-contrast microscope, etc., are all either omitted or abridged without sacrificing the essentials of optical technology.

Principles and practice of methods of inspection of plane and spherical surfaces by interference phenomena are described in a manner just enough for the routine technician, who is not bothered about definitions, tolerances and plane parallelism. The chapter on the constitution and properties of dioptic substances is completely omitted and the subject of testing of raw optical glass abridged to suitable proportions. The first chapter containing historical matter running to 16 pages could as well have been omitted thus further reducing the bulk and price of the book.

With all the non-essentials omitted in the abridged edition, the value of this book as one for reference is not very much diminished. To one who is interested in the principles of optical manufacturing technique, it makes pleasant reading. To the routine technician the book is indispensable. Even to the expert in this line, there is much to study and learn.

I. RAMAKRISHNA RAO.

The Quantitative Analysis of Drugs. By D. C. Garrat. (Chapman & Hall), 1955. Pp. xv + 670. Price 70 *sh.* net.

The first edition of this book was published in the year 1937 under the title "Drugs and Galenicals: Their Quantitative Analysis". The book was then cordially welcomed in the field of pharmacy and particularly by those who were concerned with drug analysis. Since the publication of the first edition there has been considerable development in the field of medicinal chemistry and a second and enlarged edition of the book was long due and its publication, therefore, is most opportune.

Though the title of the book has been changed slightly, the format and the subject-matter have not been materially altered. As in the first edition, the monographs are alphabetically arranged and consist of methods for quantitative determinations of the various pharmacopœial and non-pharmacopœial substances and their salts and preparations. Besides these, there are chapters on oils, fats and waxes, essential oils, physical methods, appendices, supplement and a general index.

From a careful survey of the book it appears that the author has taken pains in bringing the subject-matters uptodate and has made substantial improvements on his first edition by supplementing additional useful materials, such as monographs on vitamins, antibiotics, steroids, sulphonamides, etc. Some of the old monographs have been deleted and others have also been rewritten. Newer analytical techniques have been incorporated wherever necessary. Additional methods outside those in official pharmacopœias have been given from the author's personal experience of analytical work of many years' standing. These will serve as test checks. A few examples taken at random will show the help that analysts may derive from such alternative assay procedures. Thus, the titration method suggested in the case of thiouracil is very simple, the modifica-

tion proposed in the assay of Liq. Ext. of Nux Vomica might help to avoid emulsions which cause great difficulty in the course of assay of the drug by B.P. method, the colorimetric method for the determination of small quantities of Jaborandi alkaloids may be very advantageous, and the volumetric methods, other than the B.P. method, furnished in the book might be useful for the assay of hydrogen peroxide as these are not influenced by the presence of organic preservatives. The modification of B.P.C. method for the estimation of hydrocyanic acid is worth noting and the colorimetric methods for the assay of digitalis glycosides might help to keep a check on their biological assay results. Mention may also be made of the colour tests furnished for cannabis which have been claimed to be more consistent than tests on animals and assessment by trained smokers.

Inclusion of a section on the general application of physical methods dealing with light absorption methods, electrometric titrations, emission spectrography, flame photometry, polarography, etc., is timely and of interest, since the application of physical methods is specially advantageous because of their specificity, speed of operation and sensitivity. Moreover, these methods are extremely helpful when only very small quantities of the sample are available. Appendices concerning the determination of extraneous matter in food and drugs and titration in non-aqueous solvents are additional improvements. The inclusion of references at the end of each monograph has been very helpful.

The book will be an essential guide and indispensable companion to all drug analysts, pharmaceutical chemists, public and toxicological analysts and others engaged in the same line.

B. MUKERJI.

Chemistry of Carbon Compounds, Vol. III, Part A. (*Aromatic Compounds.*) Edited by E. H. Rodd. Pp. xxiv + 686. Price not given.

The first two volumes of this important series are well known. They relate to aliphatic compounds and alicyclic compounds respectively. Volume III is devoted to aromatic compounds, and Part A deals with the chemistry of benzene and simpler benzene derivatives. It starts with a valuable introductory chapter containing an historical account of the development of the theories of aromatic structure from the time of Kekule to the present day, of the theory of mesmorism and of substitution in the benzene ring. About thirty years ago when the electronic theory of valency was applied to organic chemistry, the study of benzenoid compounds played the most important part. Professor Ingold, whose name has been intimately connected with these studies, has given a critical account of the various ideas which have been advanced for a clear understanding of the behaviour of aromatic compounds. Appropriate to the present state of knowledge, adequate treatment has been given in this chapter of homolytic aromatic substitution by Hey and Williams. In the succeeding chapters has been presented well established information about the different classes of aromatic compounds such as monocyclic benzenoid hydrocarbons and their simpler derivatives, halogen and nitro compounds, amines and their important derivatives, including diazo and azo compounds, phenols, alcohols, aldehydes, ketones and carboxylic acids. Chapter VI on nitrogen derivatives of aniline is the biggest running over hundred and thirty pages, and it contains a wealth of information on various aspects of the chemistry of diazo and allied compounds, including recent references on the Meerwein reaction.

The treatment of the chemistry of the simpler benzene derivatives paves the way for the study of complex type and multicyclic compounds which will be the subject-matter of Part B. The ten chapters of the present Part A are well-proportioned and constitute an important addition to the literature of organic chemistry.

T. R. SESHADRI.

Blood Coagulation and Thrombosis. (*British Medical Bulletin*, Vol. 11, No. 1.) (Published by the Medical Department, British Council, London), 1955. Pp. 1-82. Price 15 *sh.*

The introduction of anti-coagulant therapy for thrombosis has given an impetus to research in many fundamental aspects of blood coagulations. This sudden spurt of activity in various parts of the world has brought forth a flood of new facts, a re-assessment of old theories and a sense of confusion due to the lack of definition in the techniques and terminologies used. Biggs, in the opening chapter, has tried to bring order by a clear exposition of the coagulation factors and a discussion on the techniques involved in clotting. The involvement of inherited conditions and possible acquired deficiencies with recent advances in the diagnosis and treatment of Hæmophilia and the nature of circulating anticoagulants which interfere with

the early stages thromboplastin formation have been presented by Pitney *et al.* and Hougie. Ackroyd summarises the role of platelets in coagulation, thrombosis and hæmostasis and the results of their dysfunction as also the causes and effects of platelet lysis or agglutination. The hypothesis of mural thrombus being an important factor in the pathogenesis of arteriosclerosis has been revived by Duguid. Recent advances in the chemistry and mode of action of coumarin, heparin and related compounds with a comprehensive account of anticoagulant therapy comprise an important section of this monograph. Large-scale separation and purification of non-cellular components of the cellular mechanism involving fibrinogen, prothrombin and thrombin have been described by Kekwick. A historical survey of the subject of blood coagulation and thrombosis emphasizing the paucity of our knowledge and the need to reorient our concepts is ably presented by Robb Smith in the concluding chapter.

This monograph maintains the usual standard of reviews presented occasionally by the British Council, and will be found useful both by clinicians and research workers in this field of hæmatology.

M. Sirsi.

Surgery of the Heart and Thoracic Blood Vessels. (*British Medical Bulletin*, Vol. 11, No. 3.) (Published by the Medical Department, British Council, London), 1955. Pp. 171-242. Price 15 *sh.*

Surgery of the heart owes such a lot to the great advances in anæsthesia that it is fitting that the symposium should begin with an excellent chapter on "Anæsthesia for Cardiac Surgery" by Brown and Sellick. The more recent developments such as hypothermia and its practical applications, cross-circulation technique, the use of artificial heart-lung mechanisms are all dealt with in four splendid sections.

The development and application of cardiac surgery is impossible without the co-operation of the cardiologists, and there are two very good articles on the selection of patients for surgery in congenital and acquired heart disease by M. Campbell and P. Wood respectively. The surgery of patent ductus arteriosus and of coarctation of the aorta are dealt with in a lucid manner by O. S. Tubbs, himself a pioneer in the surgery of congenital heart disease. C. G. Rob and Eastcott with their almost unrivalled experience in vessel-grafting have added a very good chapter on "Arterial Reconstruction, with special reference to Homografts". Cardiac distress and arrest, of such paramount importance in surgery of the heart, are dealt with ably in a separate article.

Excellent articles by eminent authors and authorities like Sir Russell Brock, T. Holmes Sellers and others on operations for congenital heart disease, on treatment of pulmonary stenosis, on surgery of the aortic valve, of septal defects, of mitral stenosis, and on problems in the surgical treatment of vulvular incompetence complete this volume.

Surgeons in general, and thoracic surgeons in particular, will be very grateful to Sir Russell Brock, the Chairman of the Committee that planned the symposium, N. R. Barrett, the scientific editor and the other authors, for this well illustrated and valuable contribution to the subject.

U. Mohan Rau.

The Nucleic Acids—Chemistry and Biology, Vols. 1 & 2. Edited by E. Chargaff and J. N. Davidson. (Academic Press), 1955. Vol. 1: Pp. xi + 692. Price $ 16.80; Vol. 2: Pp. xi + 576. Price $ 14.50.

The two volumes on nucleic acids which have appeared recently, constitute the most exhaustive treatment available on the chemistry and biology of nucleic acids.

(i) In Volume I, emphasis is laid on the chemistry and methodology of nucleic acids. After a brief but illuminating introductory chapter by the editors, the chemistry of the hydrolysis products of nucleic acids are dealt with in Chapters 2-4.

In Chapter 2, Overend and Stacey give a detailed account of the chemistry of ribose and deoxyribose. In his article on the chemistry of purines and pyrimidines, Aaron Bendich has drawn pointed attention to the different systems of nomenclature used. The occurrence and distribution, general properties and newer developments for the synthesis of pyrimidines and purines using isotopes are also included. The chemistry of nucleosides and nucleotides has been ably reviewed by J. Baddiley. Of special interest to biochemists is the exhaustive treatment of the chemistry of the nucleotide enzymes.

The separation and estimation of nucleic acid components are detailed in Chapters 5-9. Detailed procedures for the hydrolysis of nucleic acids and spectrophotometric estimations of the purine and pyrimidine fractions are given by

H. S. Loring. W. E. Coben has contributed a chapter on the separation of nucleic acid derivatives by ion-exchange chromotography. Wyatt's article on paper chromatographic separation of nucleic acid components includes general technique, detection of purine and pyrimidine derivatives on filter-paper, quantitative estimation of the nitrogenous components of nucleic acids and chromatography of nucleic acid sugars. A cogent summary of the theory of electrophoretic separation of nucleic acid components and a description of the apparatus and techniques employed are given by Smith. In Chapter 9 Dische described colour reactions of nucleic acid components. Chargaff has presented an excellent review on the isolation and composition of a desoxypentose nucleic acids and of the corresponding nucleoproteins. The methods for the structural investigation of these compounds are also given. The modern methods of isolation and determination of the composition of the pentose nucleic acids and of the corresponding nucleoproteins have been discussed by Magasanik. Brown and Todd have adequately organised and presented with remarkable clarity, the comparatively modern work which has played a dominant role in the elucidation of the internucleotidic linkages present in both ribonucleic acids and desoxyribonucleic acids. The physical properties of nucleic acids including structural determination by X-ray diffraction and dissociation constants are described in Chapter 13 by Jordan. The next chapter by Beaven, Holiday and Johnson relates to the optical porperties of nucleic acids and their components.

In the last chapter of this volume, Schmidt deals with the enzymes attacking nucleic acid components. After a detailed discussion of the properties of nucleases, some data concerning the intracellular distribution of enzymes of nucleic acid metabolism are given.

Some minor errors, mostly typographical, were detected. On page 106, the structural formula termed 4-amino-5-imidazole carboxamide is not correct. The structural formulæ of uridine and cystine on page 139 seem to be in error. On page 274 in the last line some letters are missing.

(ii) Volume II of nucleic acids opens with a chapter by Leslie wherein a general survey of the nucleic acid content of tissues and cells is made. In this chapter a distant biological bias is discernible. A description of various cytochemical techniques for nucleic acids which have paved the way for a recognition of the intimate association of nucleic acids with genes and chromosomes is given by Hewson Swift. Dounce has presented a critical review of the various methods for the isolation of cell nuclei and nucleoli and for the determination of the chemical composition of the cell nucleus. A chapter on the desoxyribonucleic acid content of the nucleus by Vendrely is also included. In the article on nucleic acids in chromosomes and mitotic division, Bo Thorell has discussed the main results obtained by biochemical and cytological studies of the chromosomal nucleic acids and their behaviour during mitosis. A short description of the methods employed is given at the beginning of each section. The review on the cytoplasm by Hogeboom and Schneider is a competent presentation wherein they discuss the uses and limitations of cytochemical techniques. An authoritative account of the biochemical properties and the enzymic makeup of the isolated cell structures, given in this review is notable for its critical outlook. This is followed by four chapters on the biosynthesis of pentose, the purines and pyrimidines, the nucleosides and nucleotides and the nucleic acids, each of them being a masterpiece of exposition. Smellie has given a highly informative discussion of the metabolic activity and catabolism of the nucleic acids and the use of labelled nitrogen, carbon and phosphorus compounds in these studies. The closing chapters on the biological role of desoxypentose nucleic acids and pentose nucleic acids constitute a fitting finale to this useful volume.

The reviewer is particularly struck by the extensive biblography and wealth of experimental details which have been packed in these two volumes as well as by the critical approach made by the various authors, who have made notable contributions in the respective fields under discussion. This enterprise, a truly monumental one, deserves praise, and investigators on nucleic acids should be greatly indebted to the numerous individual authors for their painstaking labour.

K. V. GIRI

Abnormal and Pathological Plant Growth—A Symposium. Edited by A. H. Sparrow, Chairman, Symposium Committee. (Brookhaven Symposia in Biology No. 6, Biology Department, Brooklyn National Laboratory, Upton, New York), 1953. Pp. vii + 303. Price $ 2.10.

There seems little doubt that this subject is one of the most fertile fields of biological enquiry and has grown, in recent years, into a colossus from very small and obscure beginnings. Of course, many types

of stimuli such as physical, biological and chemical on cell response have not only fascinated the pathologist and the physiologist but also the geneticist. In any rapid-moving field of enquiry it is but natural to find oneself utterly lost unless the benefit of summarising the over-all progress is made available by stimulating symposia on the subject for those actively engaged in the field. This objective is admirably fulfilled by this timely publication.

Substances influencing the growth and differentiation of plants, cell enlargement, cell division, inhibition of root and bud growth appear to depend not only on enzyme and co-enzyme systems but on nucleic acids with an induction and pre-induction phase. There is also evidence of the participation of purines in cell enlargement. Indeed, it has been possible to grow mature plants, in the vascular cryptogams, from pieces of stem apices with or without leaf primordia. It is found that most amino acids except arginine inhibit growth but alanine, aspartic and glutamic acids encourage growth. Again, there are what are called genetic tumours initiated independent of pathological entities, be they bacterial, virus or insect, and these have been successfully demonstrated in many hybrid combinations of *Nicotiana* and appear to be found on diploid and polyploid plants whose genotypes result as a combination of genomes of two species when there was at least one complete genome of each parent species present in the hybrid. Electron microscope studies have been reported on wound-tumour viruses indicating identical form in the host plant and insect vector. The effects of virus in cells on organs already formed and in cells on organs undergoing morphogenesis are adequately described.

It is clear from the symposium that the future lines of study are to be mainly directed towards a complete understanding of the fundamental metabolic processes of plant cells with special emphasis on the causes affecting the synthesis and destruction of the naturally occurring auxins. As a means to an end, this excellently produced symposium number with select bibliography and good editing will go a long way to enthuse the specialist to greater efforts in penetrating the 'why' of abnormality in tissues. I warmly commend this book to all researchers in border-line sciences.

T. S. SADASIVAN.

Chronica Botanica, Vol. 14, No. 3. (*Plant Genera —A Symposium.*) (The Chronica Botanica Co., Waltham, Mass., U.S.A.), 1953. Pp. 92-160. Price $ 2.00.

This little reprint summarising the symposium on plant genera headed by the distinguished G. H. M. Lawrence, Irwing W. Bailey and Arthur J. Eames and four other eminent workers in different fields presents the subject in tabloid form. There are many significant statements made by the various specialists, some of which are summarised below.

As serious taxonomic work requires considerable time for adequate field, laboratory and herbarium studies, support for such work must be envisaged on a long-term basis, and as the plant kingdom is large enough to provide ample opportunities for all interested in studying its diversified members, nationalistic bias must not be a bar to consideration and evaluation of all literature on the subject. Likewise we must not restrict our knowledge to papers published in languages employing only Roman alphabets. It is necessary for the taxonomist to let the morphologist, cytogeneticist and others know of his needs, to propose specific problems for investigation, and to indicate a readiness to assist in any way possible and this could be done through botanical journals and there is considerable gain to be had from the pooling of the efforts of several specialists. The conscious or subconscious assumption that a single sample of an organ or tissue affords reliable criteria for the anatomical characterization of a species or genus clearly is untenable. It is felt that a co-ordinated cytogenetic and morphological study would provide the proper basis for problems of re-classification as constancy of chromosome numbers within a genus provides a valuable test for the inclusion or exclusion of a particular species where doubt exists. Those who feel that chromosome number and chromosome morphology are more important than similar evidences from comparable features of the plant in evolutionary and taxonomic studies are indeed making an unwarranted assumption. For, cytogenetic approaches will not provide the broad general outlines of classification within a genus, nor is it expected that given genera will always be sharply delimited by the use of cytogenetic criteria alone.

I commend this little document to the taxonomist for careful study of the pros and cons of a particular existing system of classification of Angiosperms, to begin with, prior to embarking on any major changes based on his or her

own limited observations. However, it must be added that biochemical data on the behaviour of genera and species would appear as useful a criterion as a genetical-*cum*-morphological approach which has been stressed by the authors of this symposium. It is gratifying to see that most plant virus workers are thinking in these terms even in a group that has very much less to contribute towards morphological studies.

T. S. SADASIVAN.

Books Received

The Foreseeable Future. By Sir George Thomson. (Cambridge University Press), 1955. Pp. vii + 166. Price 10 *sh.* 6 *d.*

Contributions to Plant Anatomy, Vol. 15. By Irving W. Bailey. (Waltham, Mass: The Chronica Botanica; Agra, Banwarilal Jain), 1955. Pp. xxiv + 262. Price $ 7.50.

Recent Progress in Hormone Research, Vol. XI. Edited by Gregory Pincus. (Academic Press), 1955. Pp. v + 518. Price $ 10.00.

High Vacuum Technique. By J. Yarwood. (Chapman & Hall), 1955. Pp. viii + 208. Price 21 *sh.*

Some Extinct Elephants, Their Relatives and the Two Living Species. By P. E. P. Deraniyagala. (Ceylon National Museums, Colombo), 1955. Pp. 161. Price Rs. 6.

PHYSICS IN ENGINEERING AND TECHNOLOGY

THE physicist discovers scientific principles and invents devices to describe and explain them. The technician applies and magnifies these devices for human convenience and comfort. There is no branch of engineering or technology in which one or other physical principle is not applied on a scale never contemplated by the discoverer. Faraday, at the time of his discovery of electromagnetic induction, did not visualise the modern developments in electrical production. The initial investigations on radioactivity by the British and French scientists were never with a view to develop atomic energy. It took 40 years for this immense energy, conserved in matter, to be practically liberated after the original postulate of Einstein of the equivalence of matter and energy.

Instances, without number, can be given of applications of simple physical principles, demonstrated and developed in the beginning on a laboratory scale, to large-scale engineering in a variety of branches of modern civilization.

Though specialisation in one branch of science or technology has become the order of the day, in view of the vast developments in each branch by itself, a knowledge on the part of the technician of the fundamentals of physics and its varied applications is essential for a proper understanding of the specialised role he is playing in the complicated scientific and industrial advances of the modern age. Such a basic, but comprehensive knowledge, is imparted by this book of Harris and Hummerling.

Reading through the book, one appreciates the importance of physics both as a science and in its technological applications. Each chapter begins with enunciation and explanation of the fundamentals of each aspect of physics and ends with a clear exposition of their applications in present-day engineering and technology. Principles of mechanics, heat, sound, light, magnetism, electricity, electronics and atomic physics are presented in a lucid manner, and the variety of modern developments in which these principles are utilised, described in a style capable of being understood even by the beginner in technological studies.

Precision tools embodying mechanical principles, hydraulic machines based upon principles of hydrostatics and dynamics, laws of motion as applied to the latest gears and gear systems, centrifugal forces and their role in modern transport systems, thermodynamical principles and their practical application in internal combustion engines and in heating and other types of air conditioning systems are all described in semi-popular language. The chapters devoted to sound reveal how this subject, which was till recently a dead science, is brought back to life in its varied applications in the acoustics of buildings, magnetic and mechanical recording, geophysical exploration, sound on film records, etc. Electrical machines as developed on fundamental physical principles are dealt with elaborately.

The authors have attempted to make the book thorough. In doing so, however, they have shown their bias for thermal and electrical engineering aspects at the sacrifice of optical technology, which is not treated with the importance it deserves. Excepting for this, the book is a wonderful guide for technicians of intermediate grade. The summaries, the examples worked out and the questions set at the end of all chapters enable the reader to assess his understanding of the subjects. Illustrations are copiously given for all aspects of applied physics, and add considerably to the value of the book.

I. RAMAKRISHNA RAO.

* *Introductory Applied Physics*, by Norman C. Harris and Edwin M. Hemmerling. (Mcgraw Hill), 1955. pp. viii + 297, Price $ 6.75.

SCIENCE NOTES AND NEWS

Red Rot of Sugarcane on Lamina

R. K. Singh and G. Sharma, Central Sugarcane Research Station, Pusa, Bihar, observed on leaves of sugarcane black dots in dry straw-coloured patch which were contiguous with red rot lesions on mid-ribs of Co 453 in July-August 1955. These, on microscopic examination, proved to be acervuli, and gave typical cultures of *Physalospora tucumanensis* Speg. This is the first report of the fungus appearing on leaf-lamina.

Documentation of Molecular Spectroscopy

The publication of a new system of documenting infra-red and Raman spectra is announced jointly by Butterworths Scientific Publications (88, Kingsway, London, W.C. 2) and Verlag Chemie, Weinheim/Bergstrasse, Germany. The spectra of pure compounds, and of other technological products, will be provided on punched cards, with much other structural and spectral information. A detailed code which applies to the punched holes has been designed so that the cards can be used to provide answers to a wide variety of questions which often occur in research. The spectral cards are also linked to a current literature survey, which adds to their intrinsic value. Details of the scheme which is expected to begin in 1956 with about two thousand cards annually, can be obtained from the publishers.

Dr. D. V. Bal

Dr. D. V. Bal, Professor of Zoology, Institute of Science, Bombay, has been nominated by UNESCO as a member of the International Advisory Committee on Marine Sciences. He participated in the meeting of this Committee held at Tokyo on the 24th and 25th October 1955, preceded by a Symposium on Physical Oceanography.

38th Annual Report of the Bose Institute

The Thirty-Eighth Anniversary Meeting of the Bose Institute was celebrated on November 30th, when Dr. Sunder Lal Hora, Director of Zoological Survey of India, delivered the 17th Acharya Jagadish Chandra Memorial Lecture. He chose as his subject "Conflict *vs.* Co-operation as Factors in Evolution".

The Director, Dr. M. M. Bose, in his report for the past year, observed that the Institute had submitted to the Central Government, plans and estimates for expansion of the activities of the Institute during the Second Five-Year Plan. All the plants for expansion of the research activities of the Institute depended on the provision of additional buildings for laboratory accommodation.

Reference was also made to the international co-operative work to be undertaken for the International Geophysical Year, 1958, in connection with which the Bose Institute proposes to make continuous record of intensities of different components of the cosmic rays with apparatus installed in the Mayapuri Research Station, Darjeeling.

New High Temperature Thermocouple

A new thermocouple suitable for measuring temperature in the range 1,700-1,880° C. represents a most important advance in high temperature pyrometry. This is made of rhodium-platinum alloy wires of 20 and 40% rhodium content respectively. Above 1,700° C. they give e.m.f's exceeding 4 millivolts, enabling a relatively robust and inexpensive indicating instrument to be used. The alloy can, moreover, be worked in the cold and this greatly minimises contamination during manufacture of the wires. (*Metal Industry*, September 9, 1955.)

Poliomyelitis Virus Crystallised

The University of California has announced that Dr. C. E. Schmerdt and Dr. F. L. Schaffer, of the University Virus Laboratory, have succeeded in crystallising a purified poliomyelitis virus. This is the first time a human or animal infecting virus has been crystallised.

Crystallisation of the virus is being regarded as an important step in determining the physical and chemical properties of virus disease agents.

Canadian Atomic Reactor for India

The Government of India have accepted the Canadian offer for an NRX atomic reactor under the Colombo Plan. This type of reactor is a high-powered research and experimental unit of the kind now in operation at the Canadian Atomic Energy Establishment at Chalk River. The Government of India is prepared to allow accredited foreign scientists, including those from other Colombo Plan countries in South

and South-East Asia, to use the facilities that will be available at the atomic energy centre in India.

The Institution of Telecommunication Engineers

The first series of the Studentship and Graduateship Examinations of the Institution of Telecommunication Engineers will commence on Monday, the 21st May 1956, and will continue on each succeeding days (including holidays) except Sundays. The examinations will generally be held at Bangalore, Bombay, Calcutta, Delhi, Jabalpur, Madras and Poona.

The last date for the receipt of applications is January 31st, 1956. Application forms can be had from: The Institution of Telecommunication Engineers, Post Box No. 481, New Delhi.

Regulations and syllabus for the examinations have been printed in the June 1955 issue of the *Journal of the Institution of Telecommunication Engineers*, but copies are separately available, each annas 8 (in stamps).

The Graduateship Examination of the Institution of Telecommunication Engineers offers a unique opportunity to professional men who have not had the benefit of academic training in Telecommunication Engineering at the University level. The Studentship Examinations are designed for trade apprentices who have had no formal schooling.

Titanium Purification by Zone Refining

The Westinghouse Research Laboratories have devised a method of purifyinv titanium and other hard-to-get metals by imprisoning the molten metal inside a cage of its own making. The process, called cage zone refining, uses a unique method to melt a bar of metal while the metal acts as its own crucible, thus preventing contamination by any containing vessel. The object of the process is to prepare super-pure metals.

In zone refining, a bar is melted progressively from one end to the other. The new technique applies this refining process to metals which are so active at high temperatures that they react with any crucible in which they can be heated.

The success of the method depends upon the fact that most impurities in metals have a preference for either the liquid or solid state of the metal. Iron, a common impurity in titanium, has a preference for the liquid state of titanium. When a bar of impure titanium is melted progressively from end to end, the iron concentrates in the liquid titanium and follows the molten zone to the end of the bar. This end is then cut off and discarded leaving the rest of the titanium bar purer.

Effect of Ionizing Radiation on Haemoglobin and Cytochrome

Findings that throw considerable light on the nature of the oxygen effect in modifying some of the effects of ionizing radiations on living systems are reported by H. Laser of the University of Cambridge in *Nature* (1955, 176, 361). The change produced in hæmoglobin depended on its initial oxidized or reduced state, and was independent of the presence of oxygen. That is, irradiated hæmoglobin becomes oxidized (presumably by hydroxyl radicals), whereas methemoglobin becomes reduced (presumably hydrogen atoms).

Like hæmoglobin, ferrocytochrome becomes oxidized whether irradiated in air or in nitrogen. Ferricytochrome becomes reduced when irradiated in nitrogen, but anomalously was not affected at all when irradiated in air at doses up to 35 kiloroentgens.

The catalytic activity of succinic oxidation by cytochrome c was reduced by only 15% after receiving 35 kiloroentgens in air. Tde same dose in nitrogen caused a 35% loss of activity, apparently because the initial reaction product undergoes a secondary and irreversible oxidation to a green pigment after oxygen is admitted.

Award of Research Degree

The Andhra University has awarded the D.Sc. Degree in Geology to Shri U. Aswathanarayana for his thesis entitled "Radio-Activity of Some Indian Rocks, Sea-Floor Sediments and Minerals".

The Ph.D. Degree of Osmania University has been awarded to the following scholars in the subject mentioned against their names: Shri Garikapathy Sivarama Sastry—Physics, Shri S. Balakrishna—Geology, and Shri K. N. Moorthy—Chemical Technology.

The University of Poona has awarded the Ph.D. Degree in Biochemistry to Shri S. V. Phansalkar for his thesis entitled, "Studies on Protein Metabolism with Special Reference to Utilization of Animal and Vegetable Porteins by Human Subjects".

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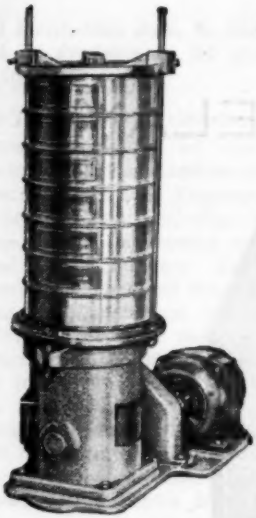

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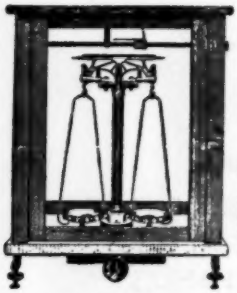

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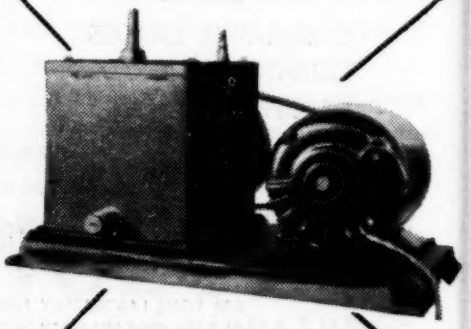

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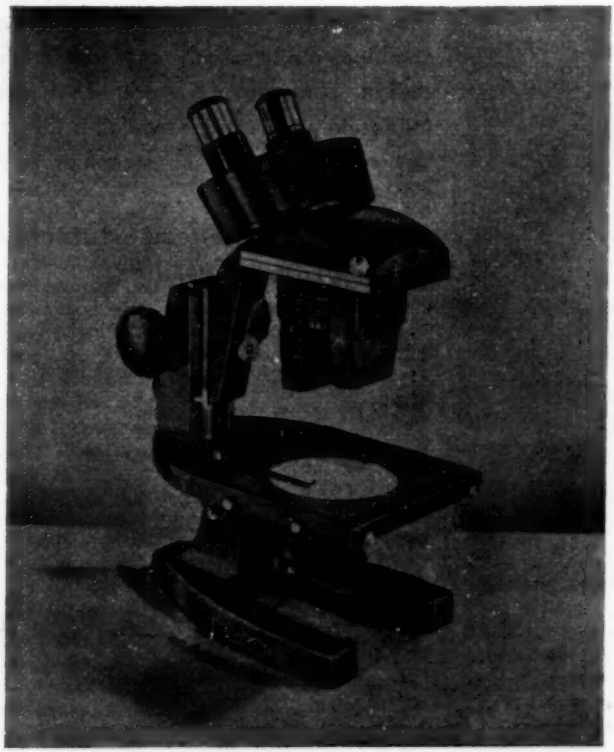

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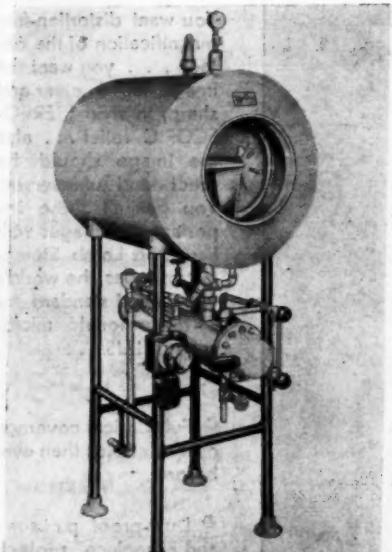

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